

BACKGROUND & POSITION PAPER
of
CHESAPEAKE UTILITIES CORPORATION
350 South Queen Street
Dover, Delaware 19901

Concerning
SUPERFUND REMEDIATION
of the
DOVER GAS LIGHT SITE

Assisted by
ORION ISSUES MANAGEMENT DIVISION,
ORION MANAGEMENT INTERNATIONAL
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AR308756

TABLE OF CONTENTS

Statement by CUC President.....	p. 3
History & Background with Site Map.....	p. 4-5
Coal Gasification Process with Site Features.....	p. 6
Discovery & Study of Site.....	p. 7-8
Study area & Aquifer references.....	p.9-10
Issues & Positions.....	p.11-56
Key Issue I: Nature & extent of underground material..	p. 11
Key Issue II: Off-site material sources.....	p. 16
Key Issue III: Aquifers & public drinking water	p. 27
Key Issue IV: Appropriate remediation plan.....	p. 30
Key Issue V: Public health, environment & costs.....	p. 34
Key Issue VI: Tar Branch & St. Jones River.....	p. 39
Key Issue VII: Slug theory & preferential pathway.....	p. 43
Key Issue VIII: Areas of responsibility for PRPs.....	p. 46
Conclusions of Remedial Investigation Report.....	Appendix A
Conclusions, Phase III Ground Water/Fingerprint Study..	Appendix B

FREQUENTLY USED ABBREVIATIONS

ARARs = Applicable or Relevant and Appropriate Requirements. (A rule-of-thumb used when evaluating remedial options against regulatory requirements.)

BTEX = Benzene, Toluene, Ethylbenzene, Xylene. (A group of volatile organic compounds most commonly found in fuel.)

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act. (It established the Superfund concept and regulates remediation of contaminated sites under the administration of EPA and State authorized agencies.)

CUC = Chesapeake Utilities Corporation (One of the Superfund site's Potentially Responsible Parties)

DNREC= Department of Natural Resources and Environmental Control (Delaware's official environmental agency.)

EPA = Environmental Protection Agency (The federal agency that regulates and enforces environmental laws and actions.)

MGP = Manufactured Gas Plant. (Refers to the coal gas plant originally operated by Dover Gas Light Company.)

PAH = Poly Aromatic Hydrocarbon. (A class of organic compounds associated with various fuels, coal or coal tar.)

PRP = Potentially Responsible Party. (Referring to those who may be held liable for remediating a contaminated site.)

SARA = Superfund Amendments and Reauthorization Act. (It expands CERCLA regulations on matters of public health exposures to hazardous materials or sites and procedures regarding them.)

VOC = Volatile Organic Compound. (gaseous liquids.)

AR308757

PUBLIC, CORPORATE AND ENVIRONMENTAL RESPONSIBILITY

Approximately forty-five years ago, the old Dover Manufactured Gas Plant ceased operation and was demolished. The demolition and site clearing were performed at the direction of the State of Delaware, the new property owner, according to acceptable methods at that time. Unfortunately, those methods do not meet current environmental standards and practices. As a result of the disposal methods used, some residual materials have slowly migrated from the site into the groundwater in the immediate vicinity of the site. The groundwater affected does not provide any drinking water to the City of Dover, and there is no exposure to the public.

Since Chesapeake learned of the potential impacts in 1985, it has taken the initiative in planning for environmental remediation. Chesapeake has cooperated with the Delaware Department of Natural Resources and Environmental Control (DNREC) as well as the Environmental Protection Agency (EPA). EPA entered the picture in 1991 when the site was classified as a Superfund project.

To date, CUC has spent more than \$2.7 million on numerous studies to understand the nature and extent of impact and prepare for remediation. While CUC was acting as a good corporate citizen, its extensive testing discovered that there were other sources of compounds not associated with the gas plant. This complicated and expanded the area of investigation. Various tests and studies show CUC's area of responsibility ends approximately 800 feet east of the Gas Light Site yet Chesapeake studied an area all the way to the St. Jones River and 4 blocks wide. Even in the limited area affected by the site, there is an overlap with others who have contaminated the groundwater.

Just as CUC has proven its intention to resolve the problem, CUC also expects others involved to pay their fair share in any remediation. CUC also expects that the actions taken do not exceed what the public, the environment and the situation require.

CUC will continue to cooperate with the Agencies, as it has to date. It will also keep the environment and the public interest uppermost among its concerns as the project proceeds, without compromising its duty to protect the economic interests of the area it serves as a public utility.

Ralph Adkins, President & CEO
Chesapeake Utilities Corporation

HISTORY & BACKGROUND LEADING TO SUPERFUND SITE AT DOVER GAS LIGHT

The site is located in Kent County, Delaware, within the city limits of Dover. The site occupies the western half of the city block bounded by New Street, Bank Lane, North Street and Governors Avenue.

The Dover Gas Light Site was first used for production of gas from resin for street lights in 1859. Coal was not used as a raw material until after the Civil War. Cast iron gas mains, some of which were used even after the end of manufactured gas operations in 1947, extended east from the gas plant to State Street. There the mains branched into a T-shaped configuration reaching south through The Green to Water Street and north to Reed and North Streets.

By 1870, new owners had constructed 5,000 additional feet of piping and more was added at later dates. Most of the buildings that later came to be associated with the Dover Manufactured Gas Plant were not built until the early 1880s. The original retort house was the only building dating from this early period of coal gasification that was still on site when operations ceased.

Dover Gas Light Company was incorporated in 1881. At that time, the plant was producing 6 million cubic feet of gas annually. By comparison, the New York Gas Light Company produced that much gas in two days. This suggests a relatively small operation.

In 1942, the Dover Gas Light Company was sold to Harrison and Company, a Philadelphia investment banking firm. That company was also instrumental in the formation of Chesapeake Utilities Corporation, (CUC). In this manner, Dover Gas Light Company became a predecessor company to CUC.

The Dover Gas Light Site was sold to the State of Delaware in December, 1949. As a condition of sale, the buildings were demolished and removed from the site for disposal, with the exception of the original retort house. This building was used by the Delaware State Museum to store heavy exhibits until the mid 1980s.

In 1955, the remainder of the property was leased to the Dover Parking Authority for use as a municipal parking lot. In 1966, the Johnson Building of the State Museum was constructed on the southwest corner of the site. The storage building, which was the original retort, was damaged in a fire on July 1, 1982, and the building was demolished and removed several years later.

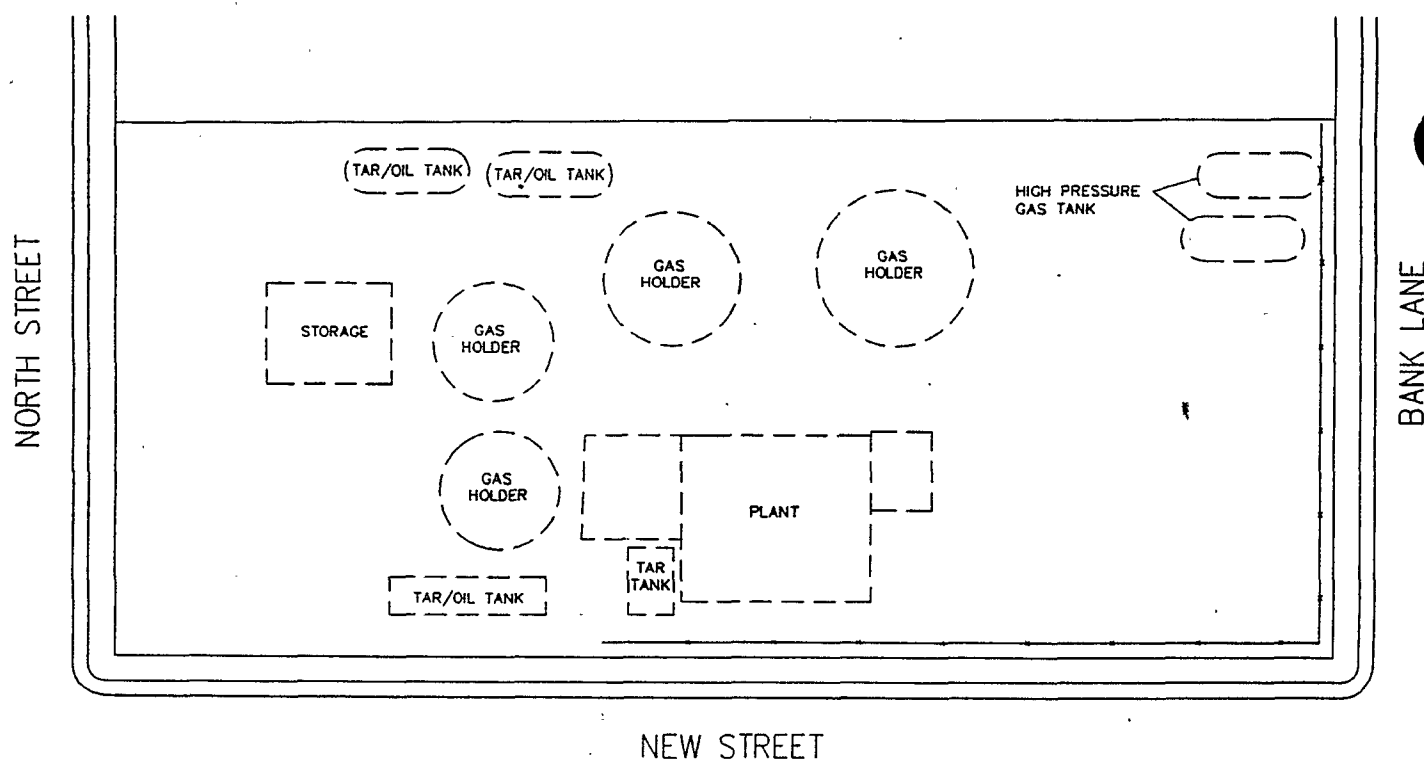
LOCATION OF SITE: CITY OF DOVER, KENT COUNTY, DELAWARE



DESCRIPTION OF THE OLD COAL GASIFICATION PROCESS

In simple terms, gas was extracted from coal by a coking process. That is, by subjecting it to high temperatures in an oxygen-starved atmosphere (a retort). The gases driven off then were condensed and separated by density in special vessels. Some gases became liquids ranging from coal tar to kerosene and ammonia liquor, which were marketable by-products. These compounds settled out and were collected. The more volatile gases remained and were purified before storage in inverted iron tanks whose bottoms were submerged in water. This served to confine the gas and develop the for distribution through the mains under city streets.

FEATURES OF DOVER GAS PLANT



DISCOVERY & STUDY OF THE ENVIRONMENTAL PROBLEM

Compounds from the former gas light plant were first discovered in 1984 when Duffield Associates, Wilmington, Delaware, conducted a geotechnical investigation for the State of Delaware prior to construction of a planned court building. Soil tests performed by Duffield indicated buried building debris, "oily" samples and fuel-like odors. The consultants concluded, after additional studies, that the materials should be classified as hazardous under EPA regulations and notified the State.

Additional testing by the Delaware Department of Natural Resources and Environmental Control (DNREC), which included the installation of 16 monitoring wells, lasted into 1985. Results showed in some of the wells the presence of benzene, ethyl benzene, toluene, xylene, naphthalene, pyrene and several other compounds at levels in excess of 1,000 parts per billion (one part per million).

Although CUC had no remaining proprietary rights at the site, it recognized that the problem extended from its days as the successor-owner of Dover Gas Light Company. Seizing the initiative in the fall of 1985, CUC hired environmental consultants (Versar Inc., Springfield, Va.) to study the situation. The study, which spanned five years, included:

- * Seven more ground water monitoring wells (added to the existing 16).
- * Collection of samples from the wells for lab analysis.
- * Characteristics of aquifer levels and directional flow rates.
- * Collection and testing of surface water samples at three locations along Tar Branch, a nearby drainage culvert.
- * Collection and testing of surface water samples at five locations along the St. Jones River.
- * Collection and testing of sediment samples from these stream locations.
- * Observations on air emissions and ecological health.

These extensive assessments confirmed the following:

- That the ground water beneath the site had been impacted by site-related compounds from coal tar.
- That compounds had migrated off-site to the southeast within the topmost aquifer (Columbia).
- That the deeper aquifers (Frederica and Cheswold) were not affected.
- That surface water in the Tar Branch and the St. Jones River were not impacted by compounds detected on site.
- That there were no detectable impacts on ambient air.

- That the biological communities near the site did not appear to be stressed.
- That no reasonably-construed pathways of human exposure existed at the site under the existing conditions.

The report covering these matters was prepared by Versar for CUC prior to EPA's involvement in the site and did not undergo review by the agency. The site was placed in the EAA Superfund program in 1990.

Since that time, CUC has undertaken additional tests or studies covering an area about 1,100 feet wide and 3,000 feet long, much of which had been covered in previous studies. The latest studies or tests included:

- * Geophysical surveys using electromagnetometry and ground penetrating radar.
- * Aerial photographic studies.
- * Archaeological and archive studies.
- * On-site source characterization study.
- * Hydrogeological pathway analysis.
- * Aquifer pump tests and characterization.
- * Surface water and sediment sampling at a multitude of locations on the St. Jones River and the Tar Branch.
- * Ground water studies (three phases).
- * Historical air quality assessment.
- * Baseline risk assessments.

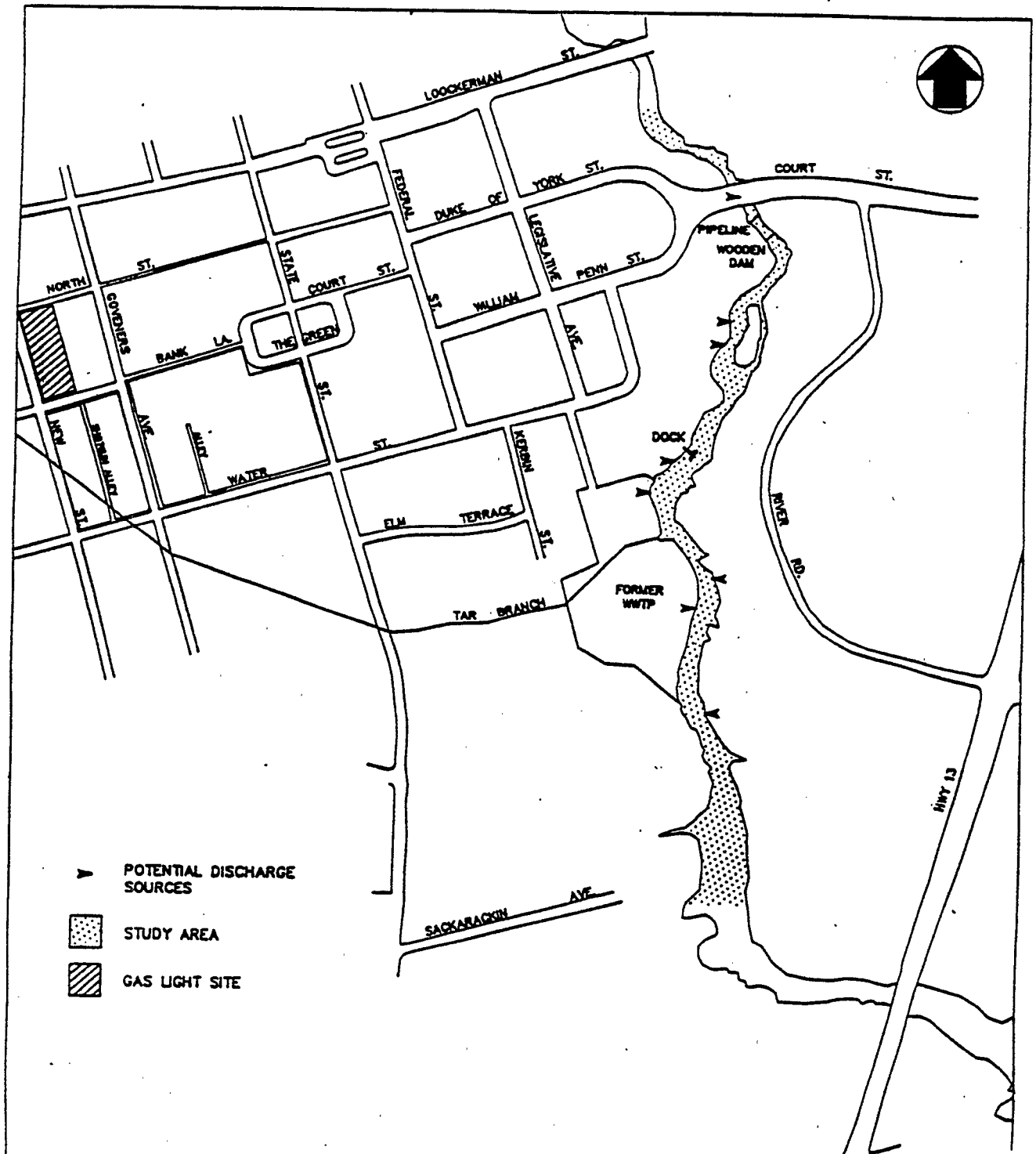
These and related investigations formed the basis for the RI/FS Work Plan and several interim reports to the EPA and DNREC, as well as the Remedial Investigation (RI) Report and the Feasibility Study (FS) Report, which are at the heart of the remediation process.

It was not until after the latest investigations began that discoveries were made of additional off-site contamination from other sources, and that CUC's area of responsibility extended only about 800 feet from the Dover Gas Light Site.

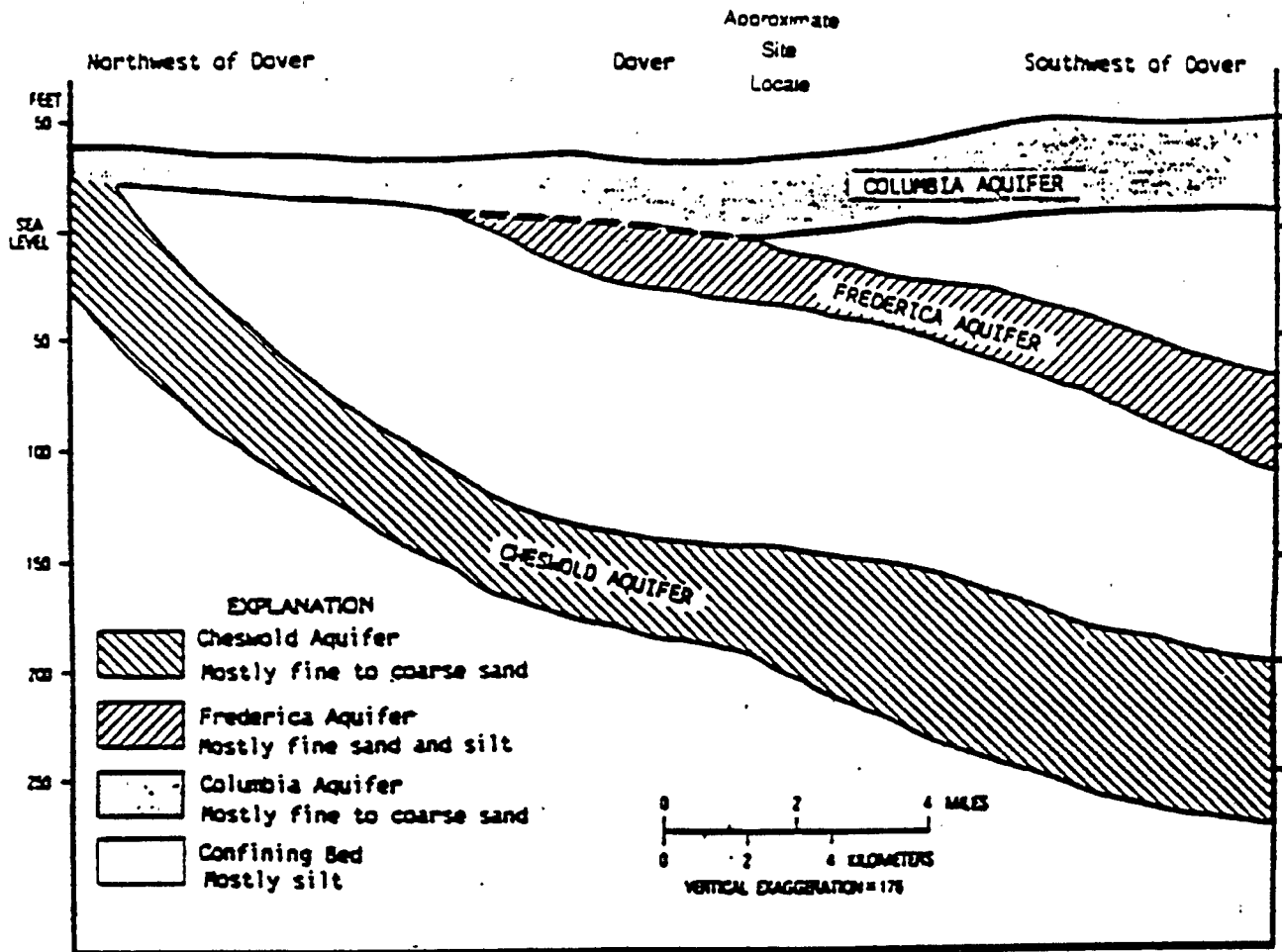
In September 1993, CUC completed a Ground Water Phase III report covering off-site contamination and chemical identification by source "fingerprinting." This study pinpoints which of the underground compounds originated or did not originate from the Dover Gas Light Site.

(See map, next page, for study area reference.)
(See map, following, for aquifer references.)

SITE & STUDY AREA



AREA AQUIFERS IN RELATION TO SITE



I. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: The extent and magnitude of impacts from MGP site; whether those site compounds reach as far as the Capitol complex or the St. Jones River.

POSITION: The site compounds in groundwater become undetectable approximately 800 feet east of the site, short of the Capitol complex and the Saint Jones River. Monitoring wells, soil borings and chemical "fingerprint" tests provide the evidence.

COMMENTARY: The compounds at the MGP site consist of Poly-Aromatic Hydrocarbons (PAHs) and benzene, ethyl benzene, toluene, and xylene (BTEX) compounds, which are below the ground surface but above the water table. The compounds travel downward and then laterally with the migration of groundwater in a southeasterly direction off-site. They are no longer detectable at approximately 800 feet, as evidenced by a "clean zone" at monitoring wells 7A, 8A, and 9A, and P-11, which is a Ground Water Phase III investigation location at the water table.

Discovery of PAHs and BTEX compounds at wells and investigation locations beyond those points are attributed to sources other than the Dover Gas Light Site. This is confirmed by laboratory testing of samples. Chemical "fingerprints" using this method confirms that compounds beyond the clean zone do not come from the Dover Gas Light Site.

(See documentation that follows)

CONSTITUENTS DETECTED IN ON-SITE BORINGS,
DOVER GAS LIGHT SITE

Volatile Organic Compounds

Benzene
Ethylbenzene
Toluene
Xylene
Styrene
2-Butanone

Metals

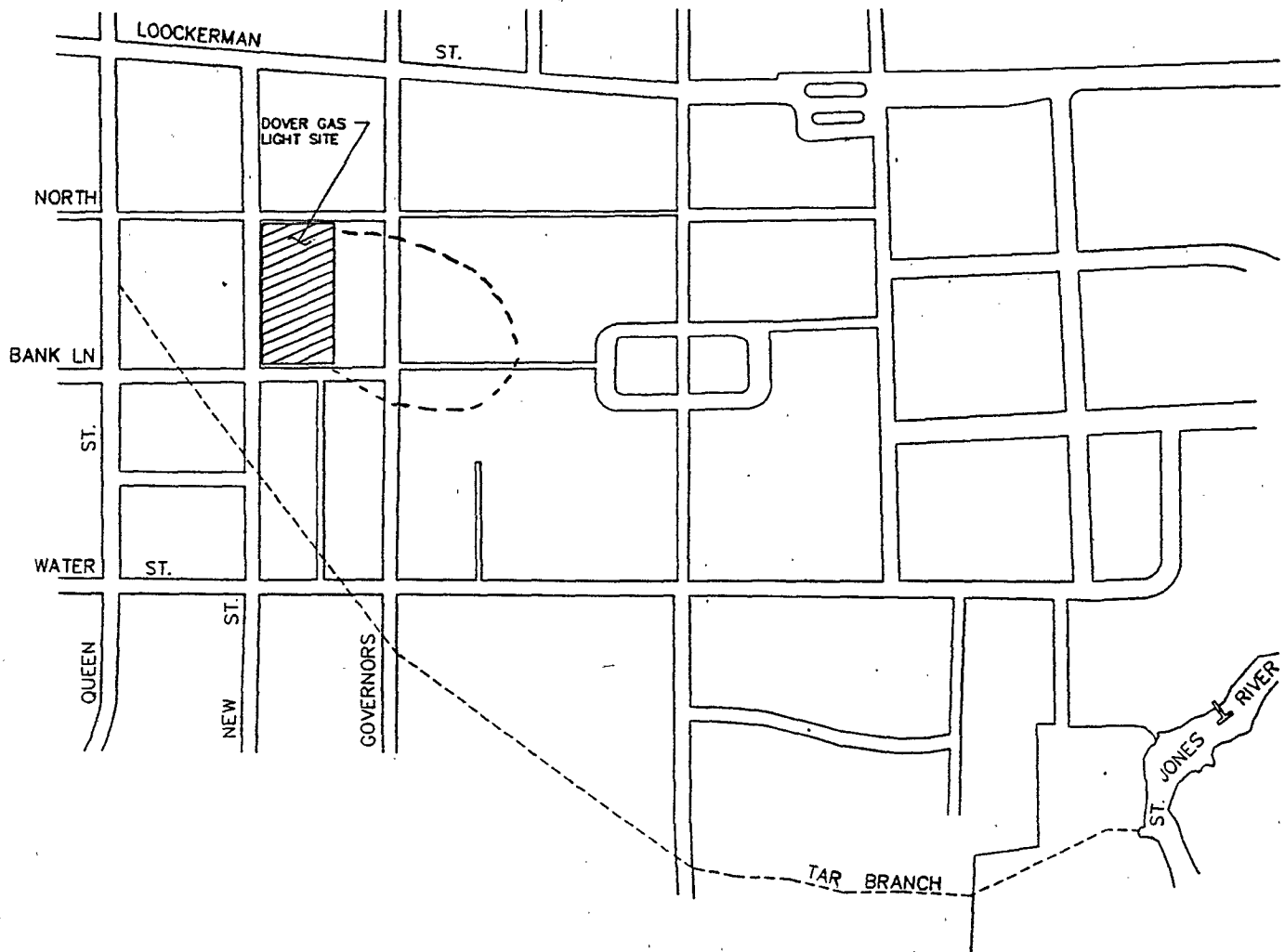
Aluminum
Arsenic
Barium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Vanadium
Zinc

Semivolatile Organic Compounds

Phenol
Naphthalene
Dimethyl Naphthalene
Acenaphthene
Fluoranthene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(k)fluoranthene
Chrysene
Acenaphthylene
Anthracene
Benzo(g,h,i,)perylene
Fluorene
Phenanthrene
Pyrene
Dibenzofuran
Benzo(b)fluoranthene
4-Methylphenol
Indeno(1,2,3-cd)pyrene

ESTIMATED EXTENT OF CONTAMINANTS FROM DOVER GAS LIGHT SITE
BEFORE INTRUSION OF OFF-SITE SOURCES

Monitoring wells indicate that compounds associated with the Dover Gas Light Site attenuate approximately 800 feet east of the site, as shown by dotted loop. However, contaminants from off-site sources begin to overlap near these points.



COMMENTS ON EXTENT OF CONTAMINATION,
EXTRACTED FROM STUDY REPORTS

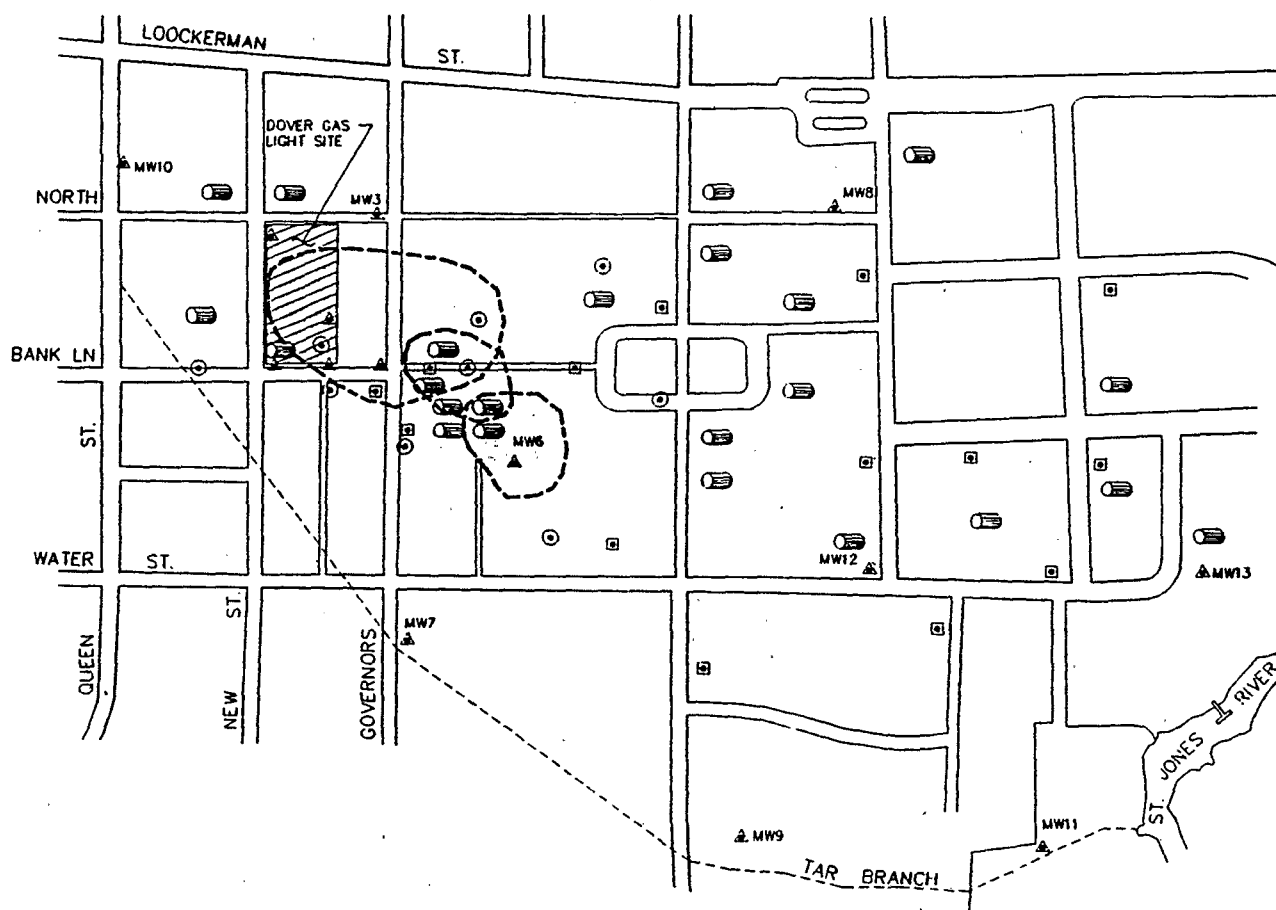
1.) "The migration route that site-related compounds follow and the distance they migrate before being naturally attenuated in the subsurface environment to concentration levels below analytical detection limits, delineates the extent of contamination." (From first page of preface to Feasibility Study)

2.) "Site related PAHs extend approximately 400 feet downgradient of the [Dover gas Light] Site, although other sources of PAH contamination, such as releases of petroleum hydrocarbon fuels from underground tanks, have significantly impacted these areas as well....The sole anomaly presented in the data is the BTEX and PAH contamination detected in Monitoring Well 13, which is approximately 2,500 feet from the site. However, there are at least three strong facts which point to an independent source at that location. When taken together, these points provide a strong basis for concluding that the contaminants detected at MW13 are not site-related." (From page 2-12 of Feasibility Study)

3.) "Selected soil sample were...chemically characterized by comparison to an existing library of chromatograms from known sources (e.g., gasoline, diesel fuel, etc.) to provide a "fingerprint" of the probable origin of organic compounds in the soil. ...One control sample obtained from the (Dover coal gas plant) site at a depth of approximately four feet exhibited detectable levels of various organics and was identified by the laboratory to be characteristic of coal tar. ...The soil samples obtained from locations (P10 through P17) and analyzed by this technique did not contain (the same characterized) compounds present above method detection limits. ...The results of the collection and analysis of ground-water samples indicate a wide range of compound levels both vertically and horizontally across the study area. The data suggest that impact to ground water east of the site are variable, indicating that multiple contaminant sources are impacting the ground water." (From page 24, Phase III Ground Water Evaluation Study.)

EXTENT OF SIGNIFICANT SOIL CONTAMINATION BY BTEX AND PAHs

Dotted lines show approximate boundaries of impacts from the Dover Gas Light Site. Drums show the location of known underground storage tanks which either are known to have leaked or are suspected to be leaking. Circles, triangles and squares show some of the sites of monitoring wells or soil borings. The large rectangle at center is The Green.



II. BASIS FOR CUC POSITION KEY ON REMEDIATION ISSUE

ISSUE: Whether off-site sources are spreading contaminants to off-site areas not reached by compounds from the site, including Monitoring Well 13, where an anomaly of contamination occurs.

POSITION: Areas east and southeast of the site are impacted from at least two other sources in addition to the MGP site itself. Compounds from other sources are being detected at monitoring well 13.

COMMENTARY: In one case, trichloroethane, a solvent commonly associated with dry cleaning, is detected off-site in migration with the groundwater. This compound is not used in the manufactured gas process and could not come from the Dover Gas Light Site. This compounds presence is consistent with the location of a dry cleaning establishment that burned down in 1989. Trichloroethane has also been detected by the monitoring wells on the edge of the Site. Its presence is consistent with the current operation of the dry cleaning establishment on the north edge of the Dover Gas Light Site. Both dry cleaning sites have a recorded history of leaking solvent and fuel tanks.

Other compounds, similar to those detected at the Dover Gas Light Site, are coming from leaking underground heating oil tanks serving the State Capitol buildings. Another source of off-site contamination is a leaking gasoline tank at the National Guard Armory, near monitoring well 13. These sources, along with contaminants from the dry cleaning sites, explain why contaminants can be found in the Capitol Complex.

Presence of these off-site sources is confirmed by DNREC information as well as a laboratory testing of samples at the Dover Gas Light Site and samples from other monitoring sites. The chemical "fingerprints" are not similar to "fingerprints" of compounds at the Dover Gas Light Site.

(See documentation that follows)

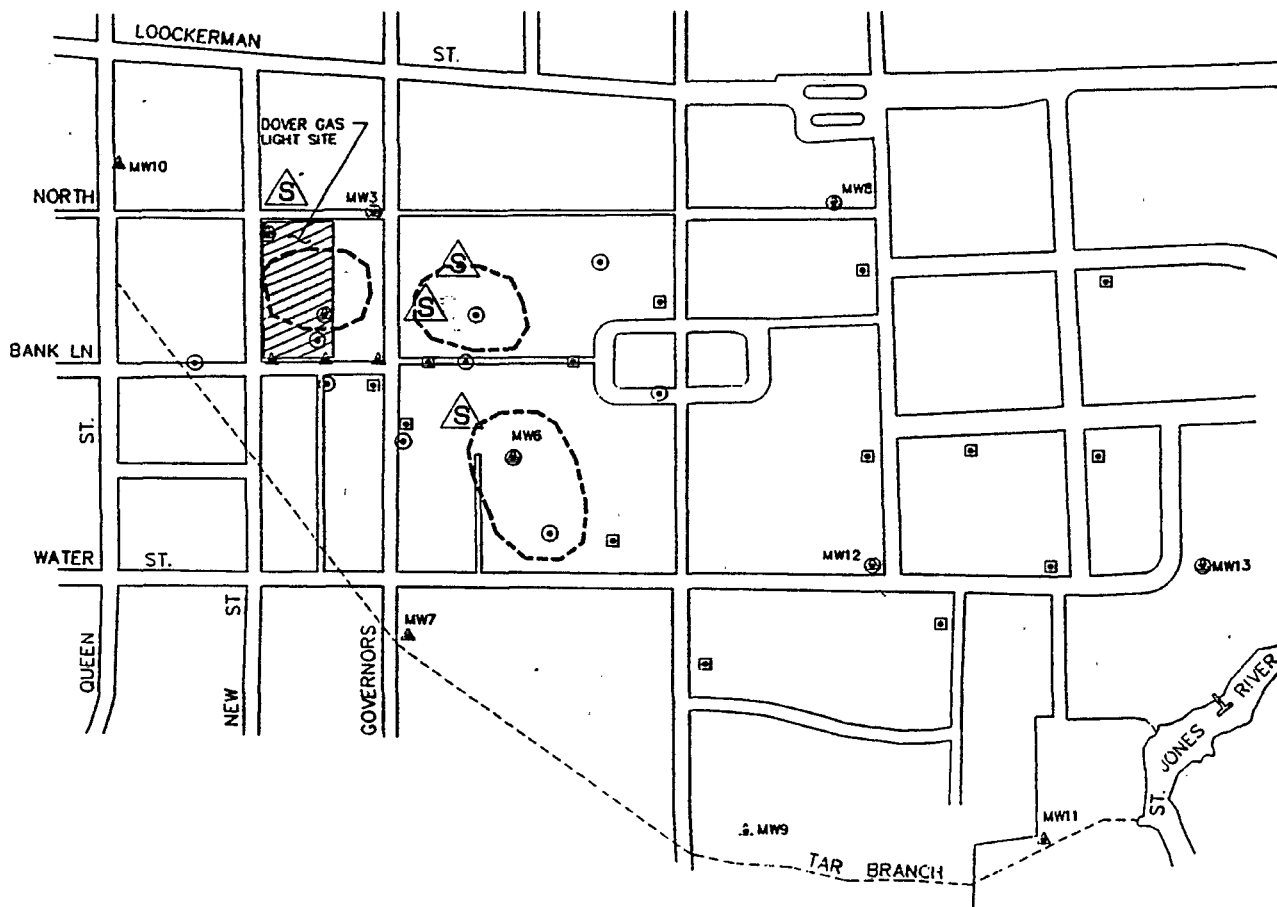
STUDY REMARKS ABOUT OFF-SITE SOURCES OF CONTAMINATION

1.) "Contamination from chlorinated compounds, which are not site-related...have been identified in isolated areas on the site. They are not site related to past activities at the site, and are the result of release from the neighboring dry cleaning business to the north and southeast, or other off-site sources... ..Chlorinated compounds are generally present downgradient from past or present dry cleaning operations, and other off-site sources for these compounds." (Taken from page 2-7, Feasibility Study.)

2.) "The lead agency, DNREC, has informed Chesapeake Utilities that they received an underground storage tank removal report (May 6, 1992) for the former Capitol Uniform and Linen Service facility located at 411 S. Governors Avenue. The report documents the removal of two fuel oil and four mineral spirits tanks. Two gasoline tanks had been previously removed. DNREC stated that releases from this location are known to have occurred and are affecting BTEX, PAH and solvent contamination in well clusters 6 and 12. ...Chesapeake Utilities observed that two steel tanks were excavated during the Spring of 1991. Close examination of these tanks indicated that numerous perforations were present in the tanks due to corrosion. The perforations in the tanks could have caused the release of product for some unknown period of time prior to the removal of the tanks from the ground." (Taken from page iv, preface to the Feasibility Study.)

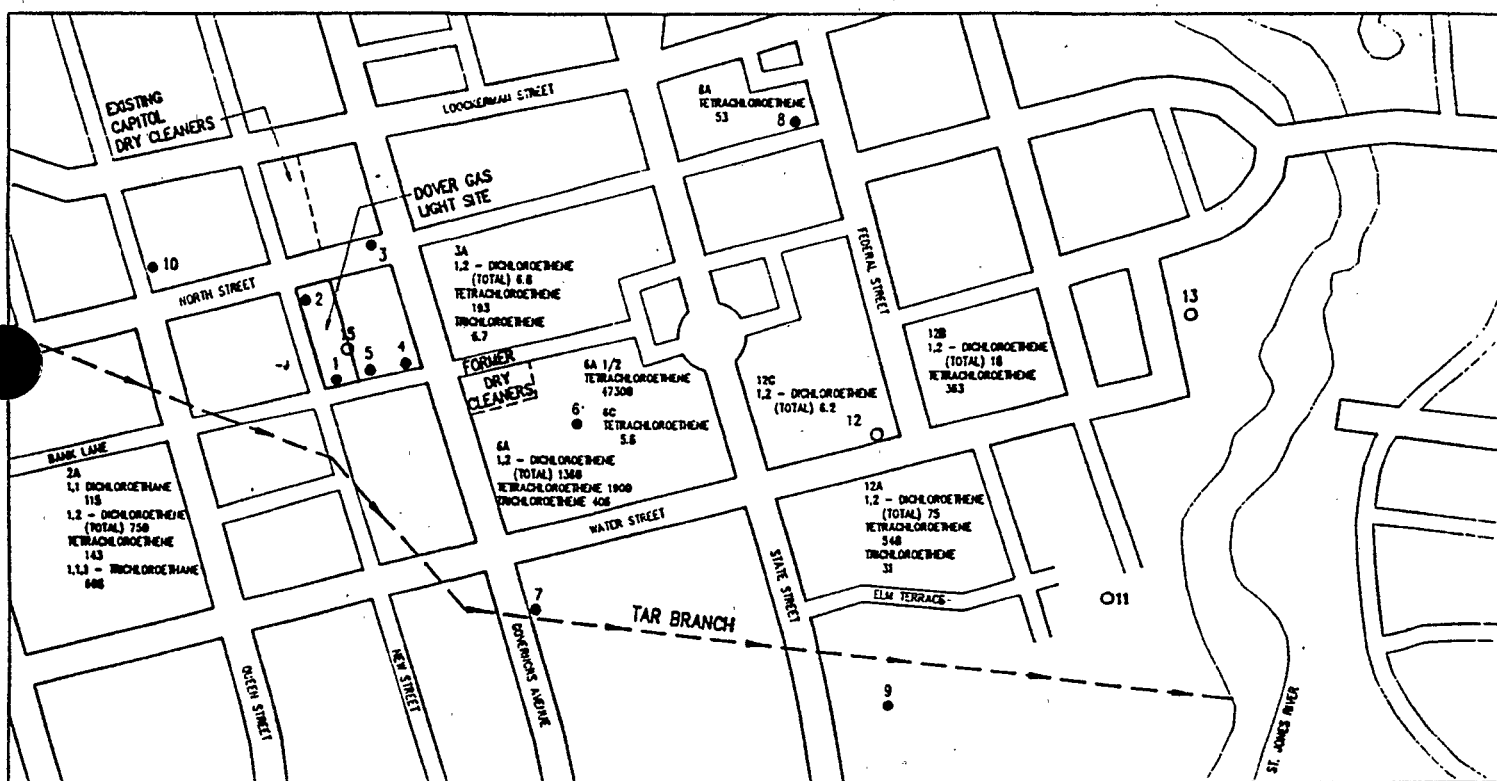
EXTENT OF SIGNIFICANT SOIL CONTAMINATION BY CHLORINATED COMPOUNDS

Triangles with S mark the surface sources for chlorinated solvent. Dotted lines show estimated areas of impact. Circles and squares indicate some of the monitoring wells and soil boring sites. Large rectangle at center is The Green.



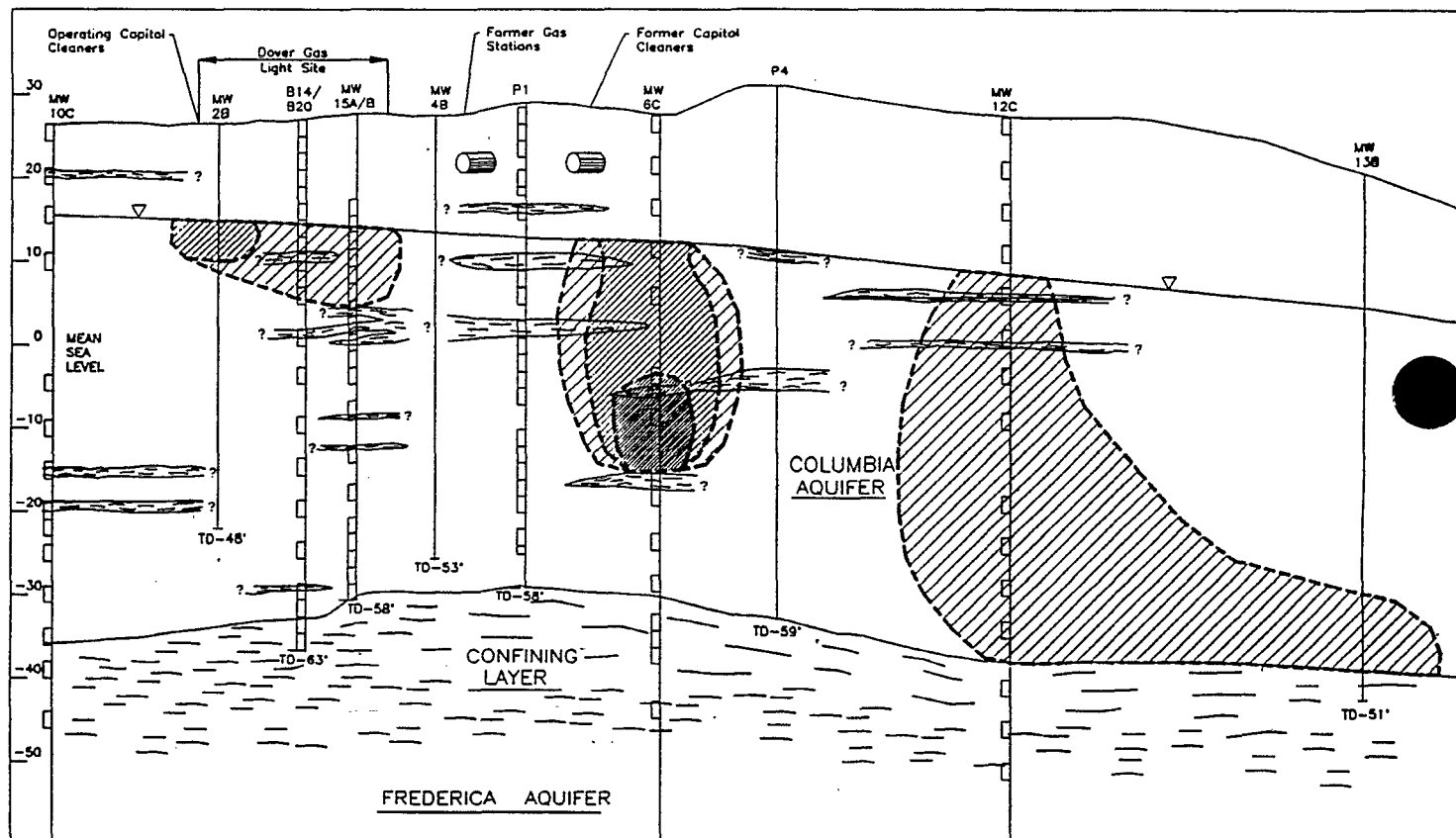
LOCATION OF DRY CLEANING OUTLETS IN RELATION TO DOVER GAS LIGHT SITE

The Site has existing dry cleaning operation to the north and a former dry cleaning operation to the south. Monitoring wells are shown by dots. Tests from wells show presence of chlorinated solvents common to dry cleaning operations.



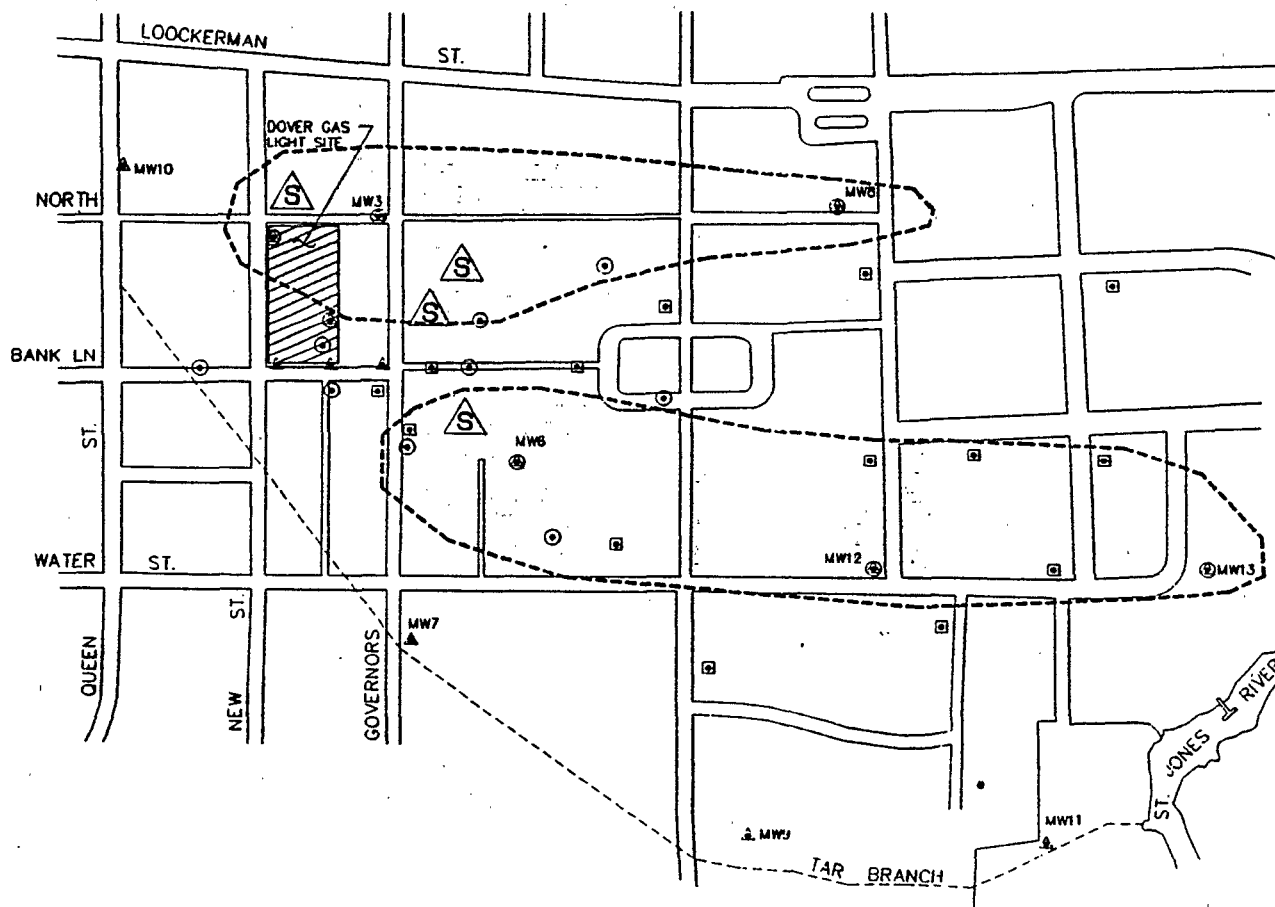
VERTICAL EXTENT OF CHLORINATED COMPOUNDS IN GROUND WATER

Shaded areas show estimates of where and how chlorinated solvents have spread into the Columbia aquifer just below the surface. The call-outs show location of dry cleaner and gas station tanks in relation to the Dover Gas Light Site.



LATERAL EXTENT OF CHLORINATED COMPOUNDS

Triangles with S show sources for chlorinated solvents. Dotted lines show extent of their spread below ground. Circles and squares are monitoring wells and soil boring sites.



STUDY REMARKS ABOUT OFF-SITE CONTAMINATION (cont'd)

3.) "Another release confirmed by DNREC was from an underground storage tank located at the Tatnall Building, a State of Delaware office building several hundred feet upgradient of well cluster 13." (It is downgradient from the Dover Gas Light Site) "DNREC provided CUC with information from a report describing the removal of an underground storage tank from this location, which indicated the presence of localized soil contamination from petroleum hydrocarbons. ...In addition, an underground storage tank was removed and replaced from the vicinity of the Jesse Cooper Building, another State of Delaware office building upgradient from well cluster 13." (The removal was in the mid-1980s.) "Field observations of a 'diesel-like odor' [was noted] during the soil boring performed in 1991 by CUC near the location of the former tank. [This] supports the idea that the tank was removed because it was leaking. Both of the tanks were used to store fuel oil of some type." (Taken from pages iv-v, of the preface to the Feasibility Study.)

4. "Locations where releases from leaking USTs have been documented include the former Capitol Cleaners dry cleaning facility...and several State government buildings including the Tatnall Building, the Jesse Cooper Building and the Delaware National Guard Armory." (Taken from page 5 of the Phase III Ground Water Evaluation Study. See also, page 34, same study.)

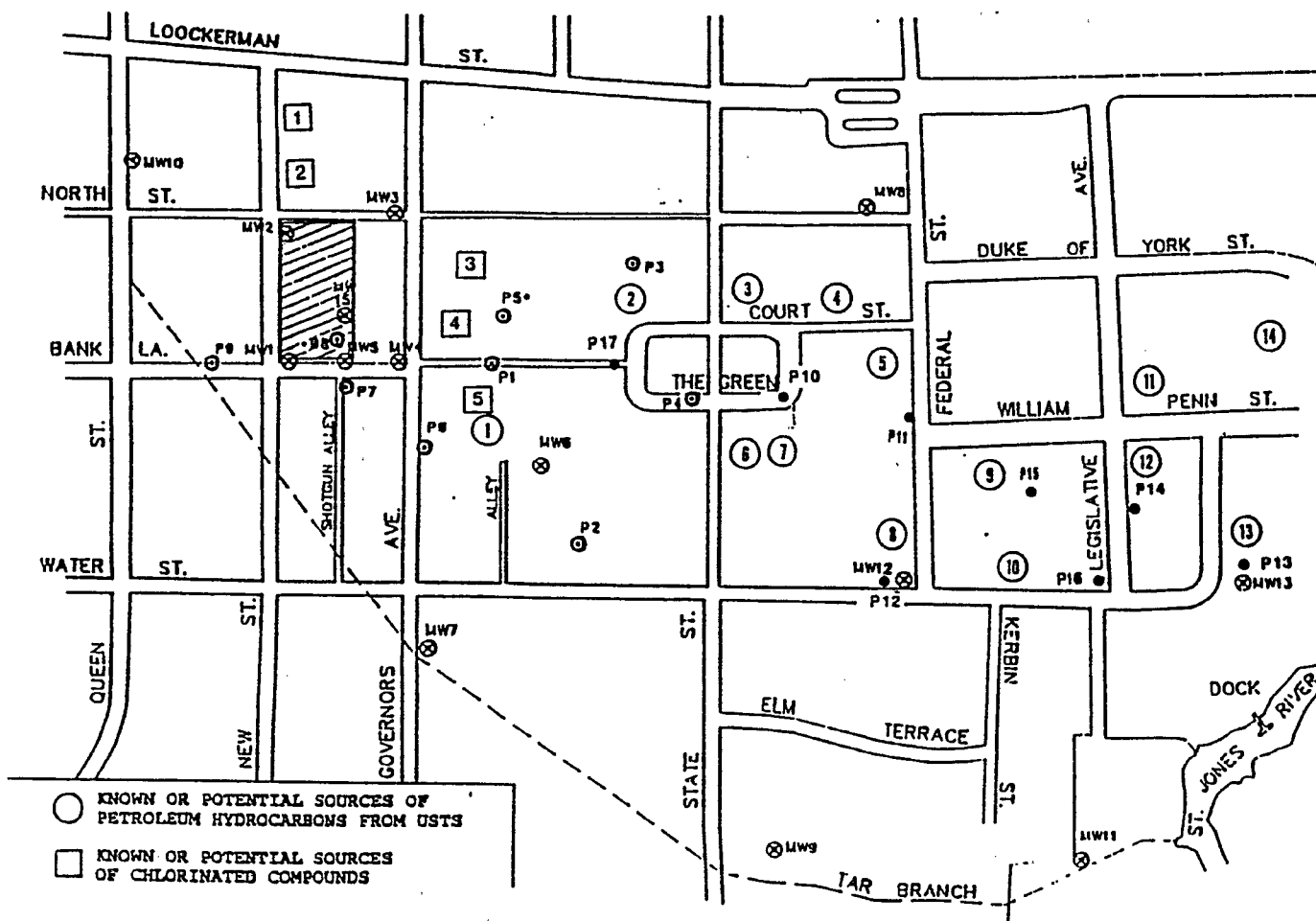
DIRECTORY OF UNDERGROUND STORAGE TANKS

List shows location of all fuel and solvent tanks in the study area, including those known to have leaked or which represent a potential source of contamination. Numbers at left match numbered location circles on map (next page).

Map Number	Location	Status
Underground Storage Tanks		
1	411 South Governors Avenue Former Capitol Cleaners Site.	Two gasoline USTs and four mineral spirit tanks removed. Known releases from this location are affecting concentrations in wells 6 and 12
2	101 Court Street	Status Undetermined
3	15 The Green	Status Undetermined
4	21 The Green	Status Undetermined
5	Federal Street Kent County Courthouse	Status Undetermined
6	The Green	Status Undetermined
7	45 The Green Kent County Courthouse	2 kerosene USTs
8	Federal & Water Street	Status Undetermined
9	Jesse Cooper Building	Heating oil UST replaced w/ new tank 1980's; 2,000 gal. gas tank ruptured in late 1980's During parking lot construction. Soil removed, no ground-water investigation.
10	National Guard Armory	Tank not in use, known to have leaked, scheduled for removal this year.
11	Legislative Avenue	Status Undetermined
12	Legislative Avenue & Wm. Penn Street Tatnall Building	UST removed. Known localized soil contamination.
13	Former DOT Laboratory	Status Undetermined
14	Court Street - Legislative Hall (State Capitol Building)	Reported UST leak - required extensive soil remediation.
Potential Sources of Chlorinated Compounds		
1	217 South New Street Capitol Cleaners	Drapery Cleaning Process
2	NE corner of New and North Streets Vacant building (for rent)	Drycleaning supplies/equipment inside.
3	309 South Governors Avenue Ellis Auto Body Works	Status Undetermined
4	317 South Governors Avenue Furniture Works	Status Undetermined
5	411 South Governors Avenue Former Capitol Cleaners site	Destroyed in fire, October 12, 1989.

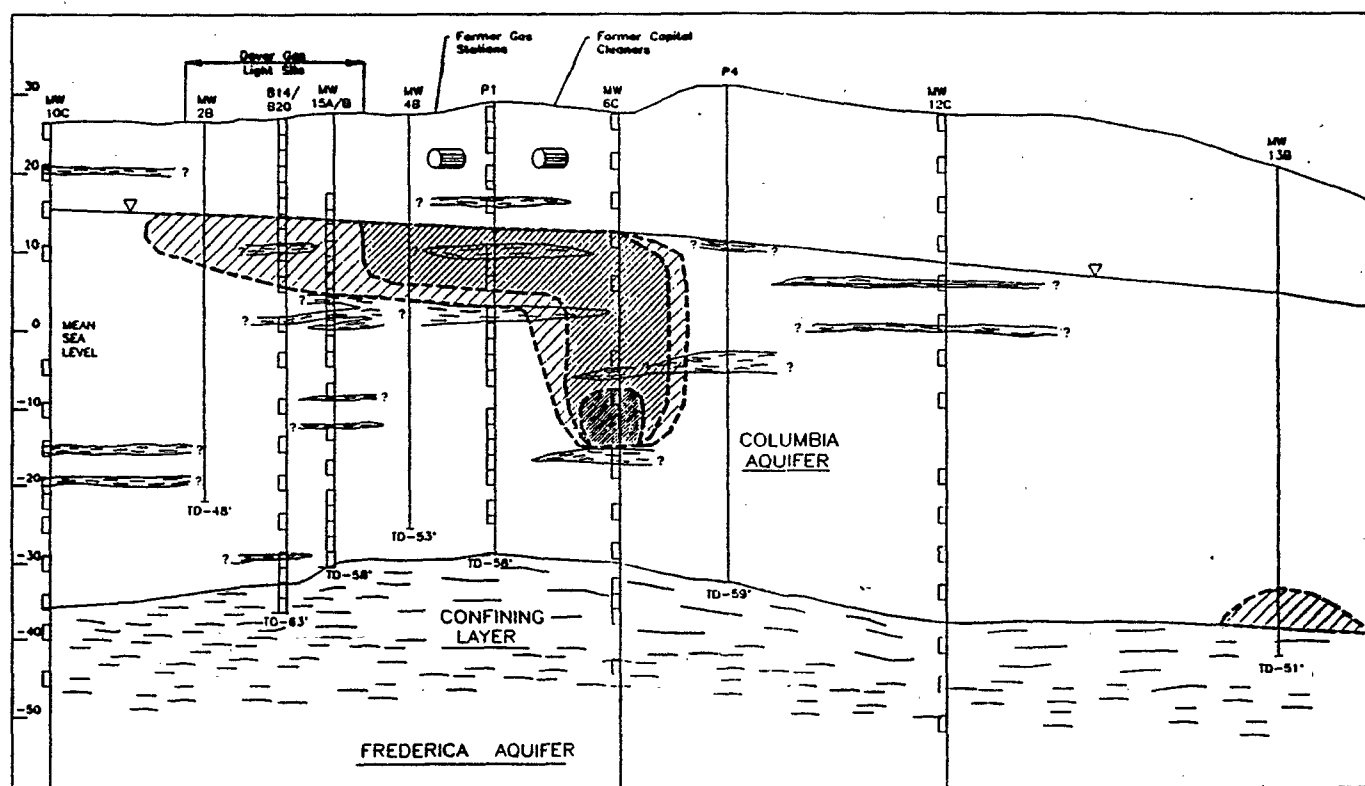
OFF-SITE POTENTIAL CONTAMINATION SOURCES

Circled State-owned fuel tanks numbered 9 (Jesse Cooper Bldg.); 10 (National Guard Armory); 12, (Tatnall Building); and 14 (Legislative Hall) are known to have leaked. These are causing PAH and BTEX contamination readings at monitoring wells in the area east of The Green, including MW13. Tank site 1, owned by Capitol Cleaners, contained two gasoline and four mineral spirits tanks which were removed. Known releases are affecting wells MW6 and MW12. In addition, releases are believed to have occurred at chlorinated solvent tank sites 2 and 5 (squares) which are affecting much of the area to the east. Solid dots indicate Phase III water study well sites. Circles with dots or X indicate earlier water and soil study well sites.



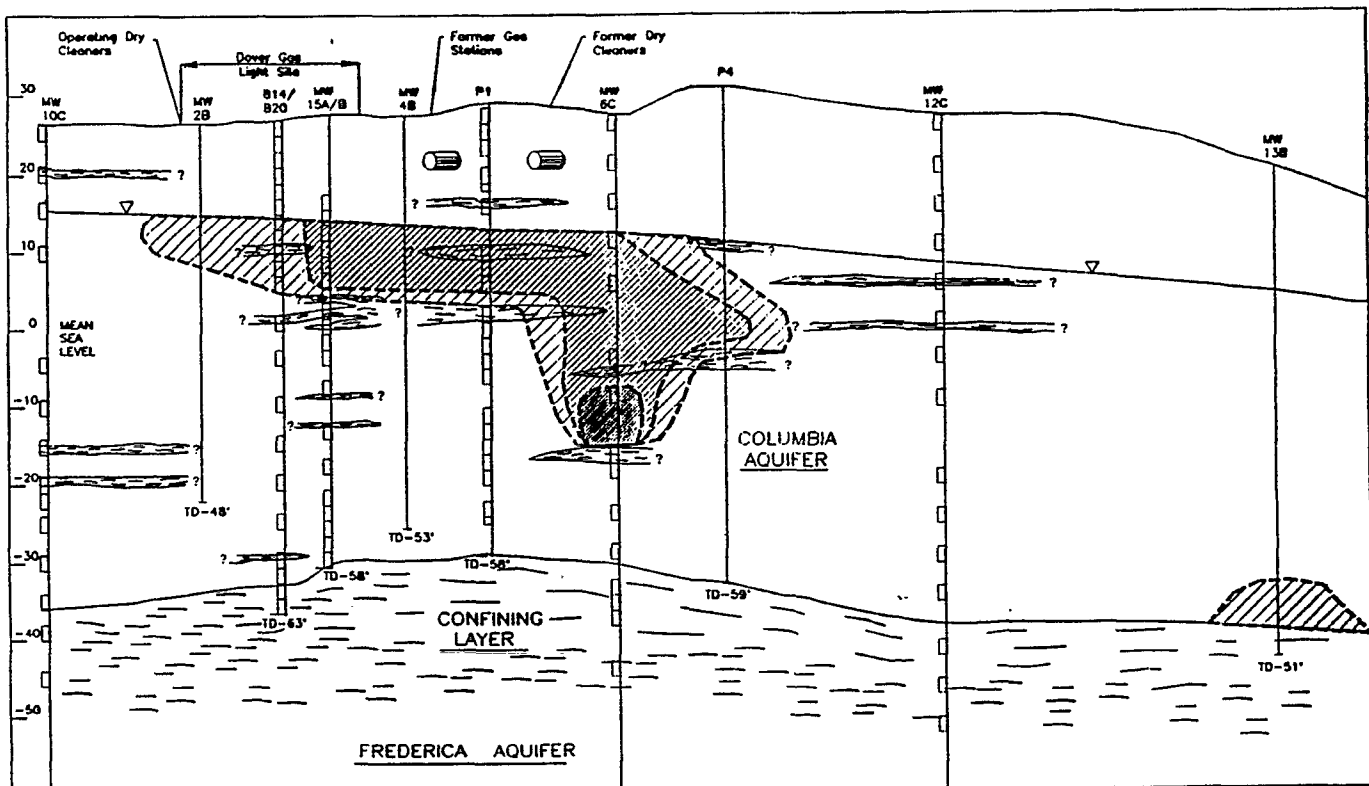
VERTICAL EXTENT OF PAHs IN COLUMBIA GROUND WATER

Impacts by Poly-Aromatic Hydrocarbons at left in drawing are combined result of Dover Gas Light Site and tanks owned by dry cleaners that have leaked. Result at right is from leaky State-owned tanks.



VERTICAL EXTENT OF BTEX IN COLUMBIA GROUND WATER

Underground impacts by benzene, toluene, ethylbenzene and xylene compounds at left in the drawing are combined result of Dover Gas Light Site and tanks owned by dry cleaners that have leaked. Result at right is from leaky State-owned tanks.



III. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: Whether the Dover Gas Light Site or other-source compounds now in the Columbia Aquifer have created a hazard to public health or the environment via drinking water, and therefore require remedial processing of water and soil.

POSITION: Impacts to the Columbia Aquifer by compounds from both the Dover Gas Light Site and other off-site sources has occurred. However, public health exposure has not occurred, nor is it threatened. That's because water in the Columbia aquifer is not used for drinking and is not available in quantities for sustained pumping to the surface. Furthermore, the area of impact geologically isolated from any aquifer that is used for drinking water, and the compounds in question are contained with no exposure to humans.

COMMENTARY: The simple presence of compounds does not automatically require direct treatment under those Superfund regulations having to do with what is relevant and appropriate. What's required is action that is appropriate for the degree of public health and environmental exposure, as determined by the remediation investigation. There is no public health hazard to remediate in the Columbia Aquifer because of the natural containment conditions which exist, and because it is not used as a drinking water source.

In addition, the Columbia Aquifer is geologically isolated from other deeper aquifers that are used for drinking water. No presence of compounds have been found in these lower aquifers. Tests also show that no contaminants from the Dover Gas Light Site are reaching the St. Jones River, the ground surface, or wetlands in the area. For all these reasons, there is no danger to public health and no reason to expend millions of dollars to extract soils or treat the water.

In fact, to treat the water at surface could expose the public to health hazards that do not now exist. If disturbance of the soil is made a part of the remediation, special protective steps will have to be taken to intervene against such exposure.

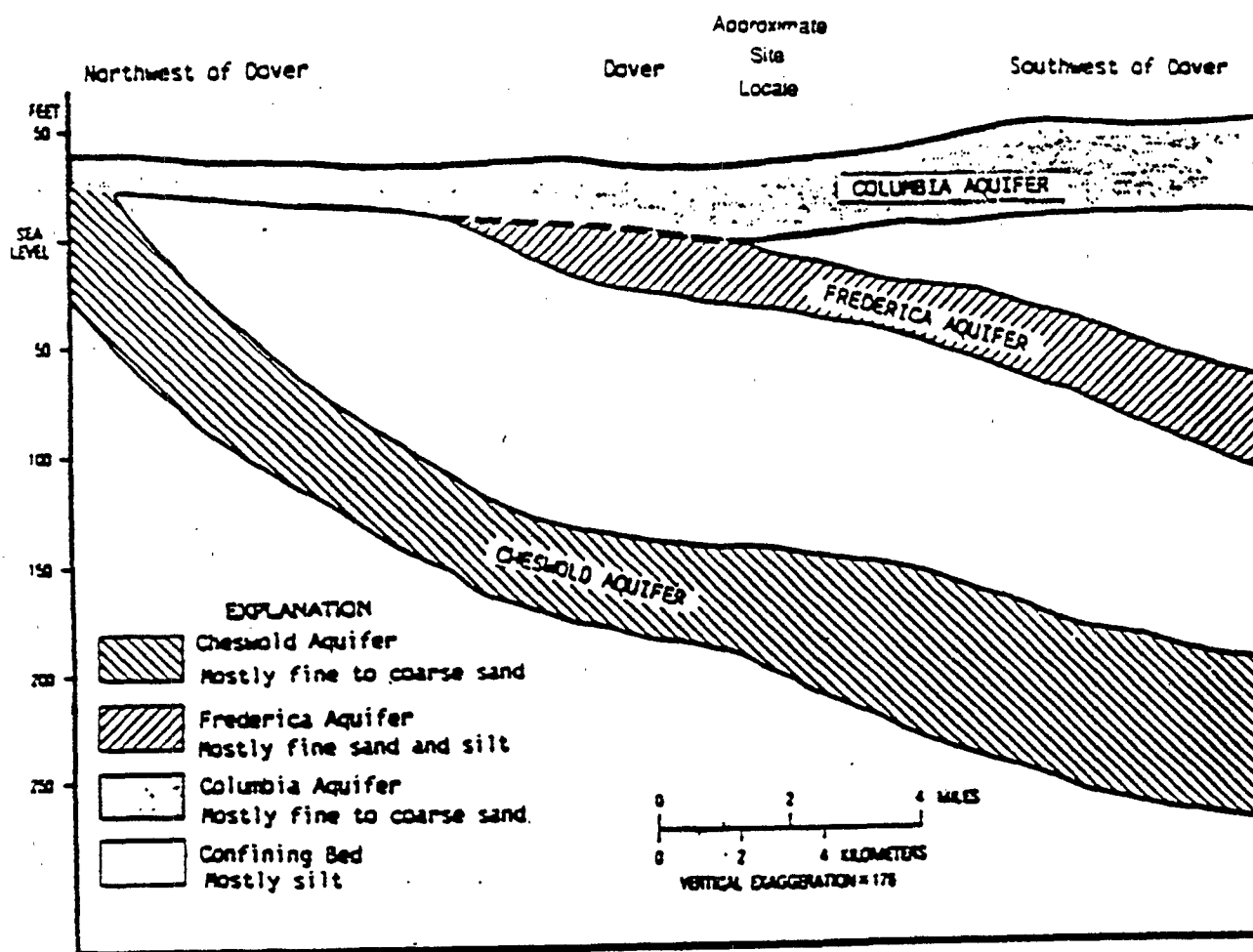
(See documentation that follows)

STUDY REMARKS ABOUT DRINKING WATER & PUBLIC HEALTH

1.) "The long term water level monitoring performed at well cluster 5 (and later at well cluster 11 and 12)...demonstrated the lack of hydraulic connection between the Columbia aquifer and the underlying Frederica and Cheswold aquifers." (The Cheswold is the source of drinking water for Dover.) "These results, particularly when read in light of the earlier test data, make clear that there is no measurable hydraulic interconnection between the Columbia aquifer, which has been impacted by site-related contaminants, and the underlying formations. Accordingly, there is no reason to expect that site-related contaminants have migrated or will migrate into the drinking water aquifers." (Taken from page 3-34 of the Remediation Investigation Report.)

AQUIFER SCHEMATIC

Columbia Aquifer, which is at surface and location of impacts, is not used for drinking water, and does not contain enough water to be useful for wells. Beneath it, separated by an impermeable layer, lies the Frederica. Far beneath it, separated by another impermeable layer, is the Cheswold, used in Dover for drinking water.



IV. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: Selecting a level of remediation that is appropriate to the source, nature and extent of the contamination and the regulations as well as the public and environmental needs.

POSITION: Given the fact that the impacts in question are not exposing a public health hazard, CUC recommends the following steps as the best for a remediation program: The paving of the MGP site, limited excavation of source materials, the monitoring of wells in the area of the Dover Gas Light Site. These steps form one of the remediation scenarios presented for consideration in the remediation plan, and it is the one which most closely meets Superfund guidelines.

COMMENTARY: The most basic requirement of any remedial action is that it is protective of human health and the environment.

Considering all the combinations of possible remedial actions, there are 11 options in the Feasibility Study. The first of these, "No Action," is relevant and appropriate, but not a solution. The second of these, "Limited No Action," is relevant and appropriate but not a good solution because it does not prevent further potential hazard. The third, "Source Area Cap/Ground Water Monitoring" is most relevant and appropriate because it takes preventive steps. In addition, is the most cost-effective, which is another Superfund requirement.

This option calls for hard surface paving of the site, which is now graveled, to prevent rain and surface water from leaching the subsurface compounds to points off-site. In addition, a limited excavation of source materials would occur, eliminating additions of compounds to the ground water. It also calls for quarterly ground-water monitoring, pumping of water from the immediate site area, and access restrictions.

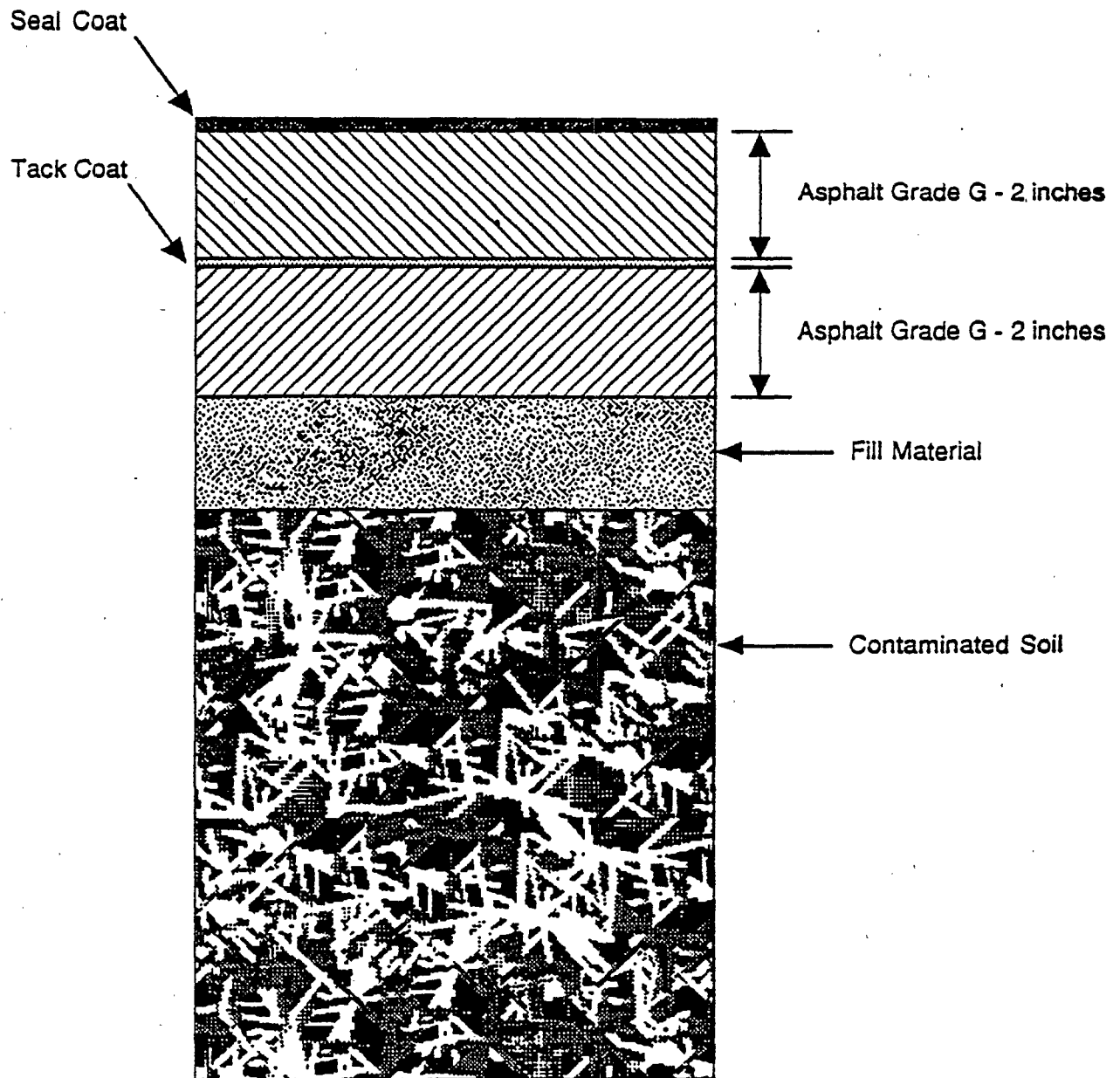
The rest of the alternatives, which require various degrees of soil digging and soil and water treatment, fail the criteria because they would expose, not protect, the public from health hazards that do not now exist. Further, the expense associated with methods that serve no public need is another key failing point.

The details of CUC's preferred plan for remediation were developed in a report submitted to the EPA, prior to EPA's release of its preferred plan. To the extent that there are differences between the two, CUC will negotiate the plan details with the EPA.

(See documentation that follows)

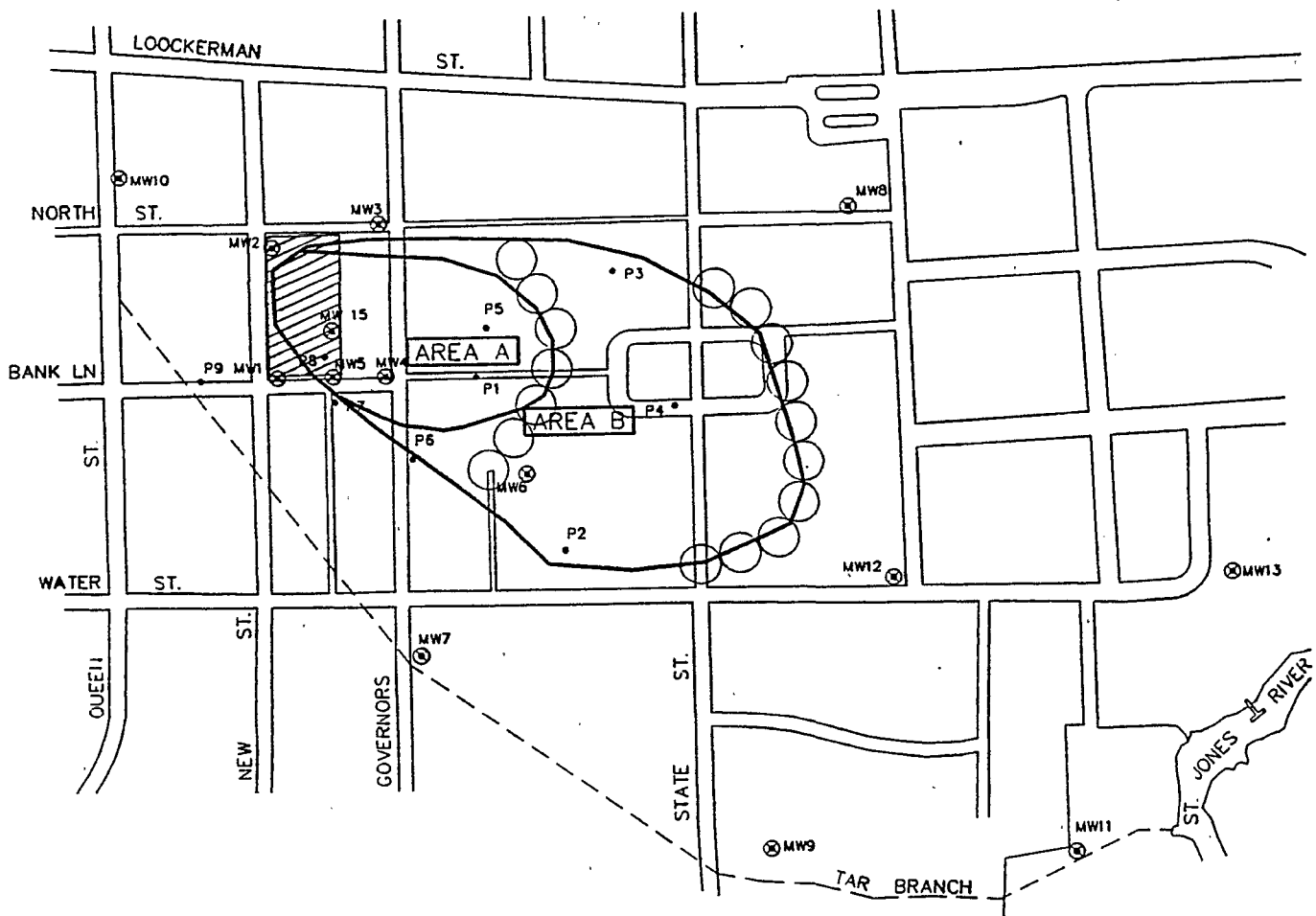
ASPHALT CAP DESIGN FOR DOVER GAS PLANT SITE

Sketch shows impenetrable seal that would be placed over the site to prevent rain water from leaching compounds off the site.



LOCATION OF MONITORING WELLS FOR REMEDIATION

In addition to capping the site (shaded area), CUC proposes to place monitoring wells (circles) at two key areas outside the site. The circles approximate the circumference that can be influenced underground by pumping the wells. Area A would control the effects of impacts from the site. Area B would control the outermost effects of impacts from the site.



STUDY REMARKS ABOUT SELECTION OF APPROPRIATE ACTION

1.) "Based on the results of the Remedial Investigation, the associated Risk Assessment and this Feasibility Study, it is apparent that the selection of an appropriate remedial action for the Dover Gas Light Site will not be prompted by current exposure risks, since none exist at this time. Complex remedial alternatives involving state of the art technologies are not warranted since the contaminants of concern associated with the site, as well as contaminants from background (off-site) sources are in the subsurface environment and are not currently subject to migrational pathways which result in human health or environmental exposure risks. Several remedial alternatives, developed in accordance with National Contingency Plan guidance, present methods to remediate soil and ground water (that are) prompted by risks which are clearly implausible. In addition, implementation of any remediation is limited by site conditions including limited access in highly urbanized Dover, historical concerns and utility conflicts.

"The remedial options presented in Alternative 4 offer little or no benefit to the environment or the community for the following reasons: First, excavating the site and removing source materials will create exposure pathways and health and safety concerns which do not exist at present. Second, installation and operation of remediation systems to treat subsurface ground water in off-site areas will have a negative impact on the community. Third, because of hydrogeologic and geochemical factors, treatment of off-site ground water to remove contaminants of concern, such as BTEX and PAHs, using traditional or innovative technologies will be marginally effective, at best, require many years to complete, and will be extremely difficult to implement in this highly developed urban area.

"Since there are no current exposure risks or pathways, and to insure they will not be created, it is recommended that deed restrictions be established on the site forbidding future excavation into the subsurface. In addition, ground water should be monitored annually to determine if the current extent of the contamination changes. This approach is consistent with remedial alternative 1b. Since the contaminants of concern associated with the site move very slowly through the subsurface environment, and current evidence suggests the rate of migration has been naturally attenuated, remedial alternatives involving major impacts to the community are not warranted." (Taken from Summary of Feasibility Study Report, page 6-6.)

Note: For a complete understanding of the remedial alternatives, see Section 5.0 of the Feasibility Report. Also, refer to the following pages in this position paper.

V. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: How public health concerns, environmental response and remediation costs are balanced in action options.

POSITION: CUC, working within Agency regulations and guidelines, has addressed these issues in a balanced manner according to Superfund requirements.

COMMENTARY: Though courses of action are complex when all the issues of concern are taken together, they are made to mesh in the recommended action plan.

The details of CUC's preferred plan for remediation were developed in a report submitted to the EPA, prior to the EPA's release of its preferred plan. To the extent that there are differences between the two, CUC will negotiate the plan details with the EPA.

(See documentation that follows)

LIST OF REMEDIATION ALTERNATIVES

- 1a. No action
- 1b. Limited no action
- 2a. Source area cap/Ground water monitoring
- 2b. Source area isolation/Ground water monitoring
- 3a. Source area cap/Ground water monitoring/Hydraulic containment
Gradient control for 30 years.
- 3b. Source area cap/Ground water monitoring/Hydraulic containment
Gradient control for 60 years.
- 3c. Source area cap/Site grout curtain/Ground water monitoring/
Hydraulic containment/Gradient control for 30 years.
- 3d. Source area cap/Site grout curtain/Ground water monitoring/
Hydraulic containment/Gradient control for 60 years.
- 4a. Removal of source material, debris, and on-site soil/
Treatment/Disposal/Quarterly ground water monitoring.
- 4b. Removal of source material, debris, and on-site soil/
Treatment/Disposal/Quarterly ground water monitoring/
Hydraulic containment/gradient control for 30 years.
- 4c. Removal of source material, debris, and on-site soil/
Treatment/Disposal/Quarterly ground water monitoring/
Hydraulic containment/ gradient control for 60 years.

(Summarized from page 5-2 of Feasibility Report.)

STUDY REMARKS ABOUT BALANCING REMEDIATION CRITERIA & COSTS

1.) Costs for implementing any of these options in Area A only would range from zero to more than \$5 million. Costs for implementing these options for both Area A and Area B would range from zero to more than \$11.5 million. Remediation beyond those areas would cost many millions of dollars more. (Based on page 6-8 of the Feasibility Report.)

2.) "Alternative 1, which essentially represent no remedial action, is composed of two options. Option 1a represents no action at all and Option 1b represents annual on-and-off site ground water monitoring. Both options are viable in terms of protecting human health and the environment since the contaminants of concern are in the subsurface environment and there are no current exposure pathways that could result in a significant human health or environmental risk.

"Alternatives 2 and 3, which consist of several options that would involve the installation of an engineered cap on the site, would protect human health and the environment by virtually eliminating the potential for contact with the source area wastes and eliminating the infiltration of surface water on the site which could percolate through source materials and leach soluble components to the ground water.

"Alternative 4, which includes three options, involves the excavation of subsurface source materials from the site, including coal tar, soil and debris, and pretreatment of these materials to make them more suitable for off-site destruction by incineration. The options include various mechanisms to contain or treat off-site contamination, but as previously indicated, there are no current exposure pathways which cause the off-site contaminants to produce a significant human health (hazard) or environmental risk. Long-term residual risk in excess of cleanup levels would be permanently eliminated by destruction of the organic contaminants through incineration of the excavated material. As noted above, however, there is little residual risk to eliminate. Accordingly, these options add little in the way of protecting public health, while greatly increasing the cost of any remediation.

"Contaminated ground water and deep subsurface soil would remain in the area affected by the site and background sources of contamination under all the alternatives. Since there are no exposure pathways at the present time and the hydrogeology factors and institutional controls presently in force significantly reduce the likelihood of such pathways being created, all alternatives, including no act, protect human health and the environment." (Taken from page 6-1 of the Feasibility Report.)

STUDY REMARKS, CRITERIA & COSTS (cont'd)

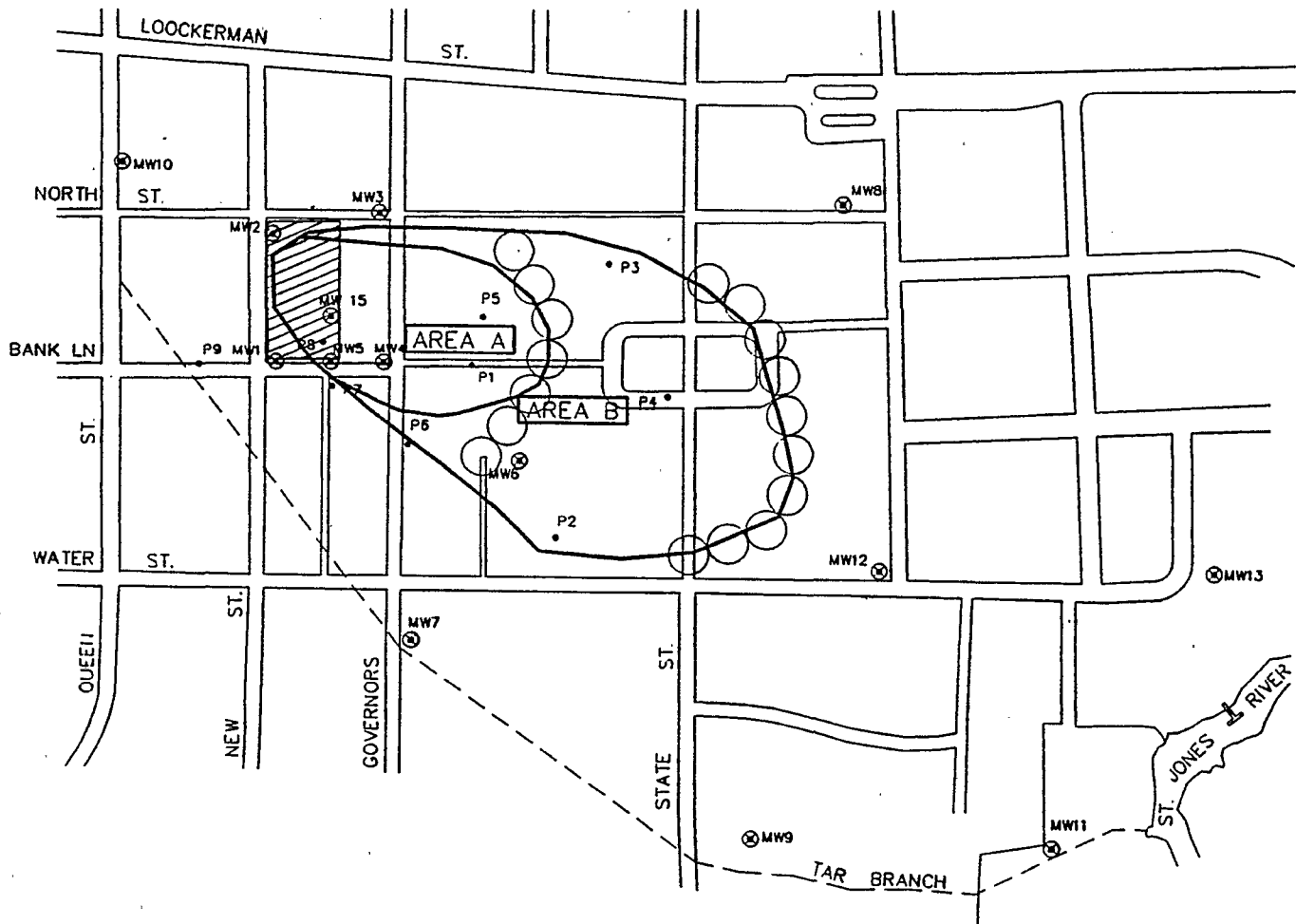
3.) Regulatory criteria that must be applied in selecting the most workable remediation options include:

- * Overall protection of human health and the environment.
- * Compliance with rules determining techniques that are applicable, appropriate and relevant (ARARs).
- * Evaluation of effects on human health and the environment during implementation until the protection is achieved.
- * Reduction of toxicity, mobility and volume of substances.
- * Evaluation of risk remaining at the site after remedial action.
- * Technical and administrative feasibility of the remedial actions.
- * Evaluation of costs involved.
- * Acceptance by State agency.
- * Community acceptance.

(Extracted from page 5-5 of the Feasibility Study. For additional information about the evaluation process, see pages 5-59 and 5-60 of the Feasibility Study.)

PREFERRED SITE REMEDIATION PLAN

Based on the above criteria, CUC suggests the area of concern be divided into three distinct zones. Area A, with seven extraction wells for hydraulic containment would control the primary area affected by the Dover Gas Light Site. Area B, with 10 extraction wells for hydraulic containment would control the secondary area affected by the Dover Gas Light Site. The shaded area of the site would be capped with asphalt.



VI. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: Whether the Tar Branch tributary of the St. Jones River is contaminated by MGP site constituents thereby impacting the river.

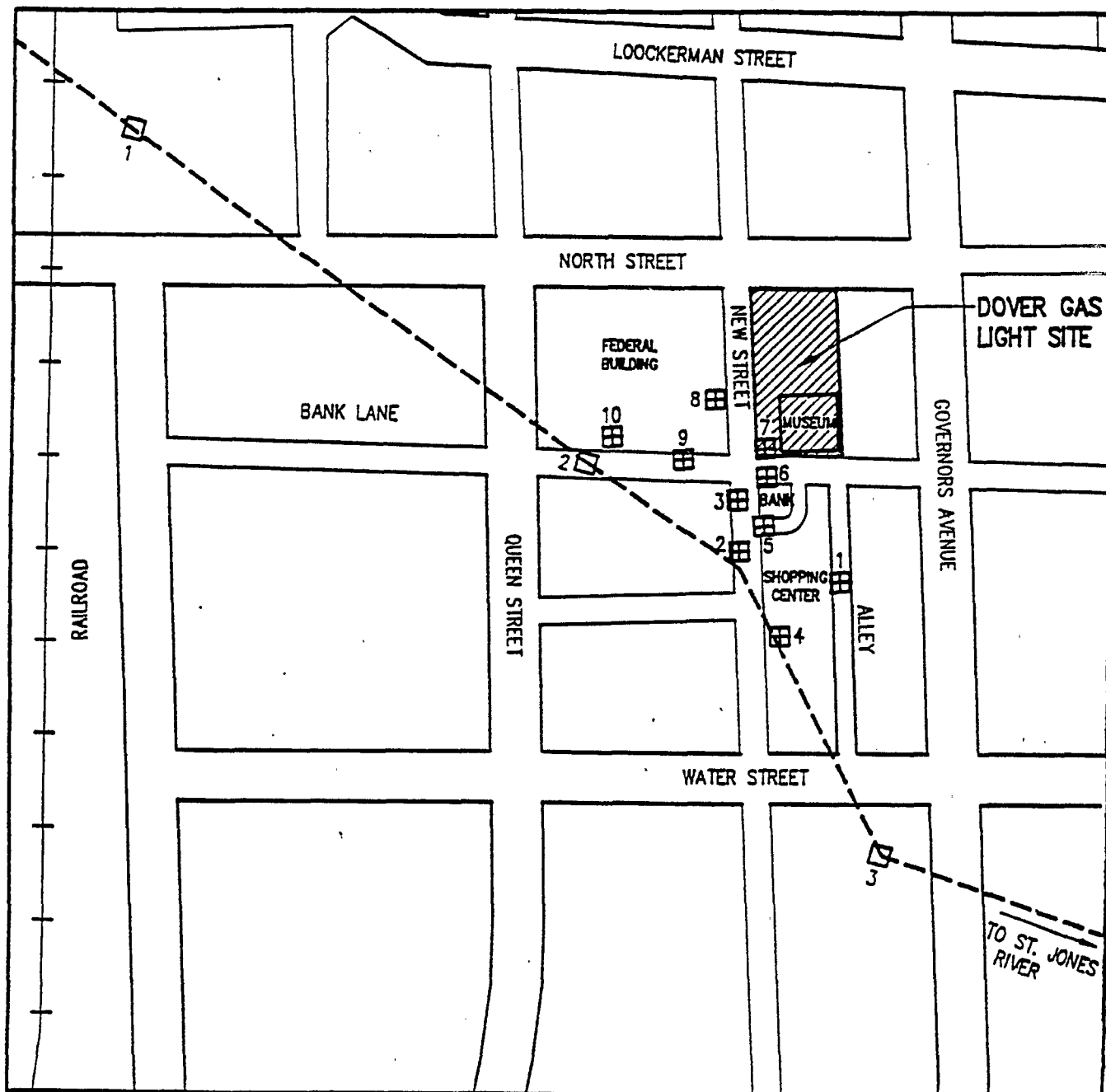
POSITION: No Dover Gas Light Site compounds have been found in the Tar Branch surface water or sediments, so none can be reaching the St. Jones River from that source.

COMMENTARY: The Tar Branch forms natural surface drainage for the terrain northwest, west, southwest and south of the Dover Gas Light Site MGP. Since 1937 it has been completely contained as a sealed culvert. Since none of the site compounds are on the surface, none are reaching the culvert via runoff. Tests of the water and sediments at several points did not detect site-related compounds.

(See documentation that follows)

TAR BRANCH SOIL BORING AND WATER ANALYSIS SITES

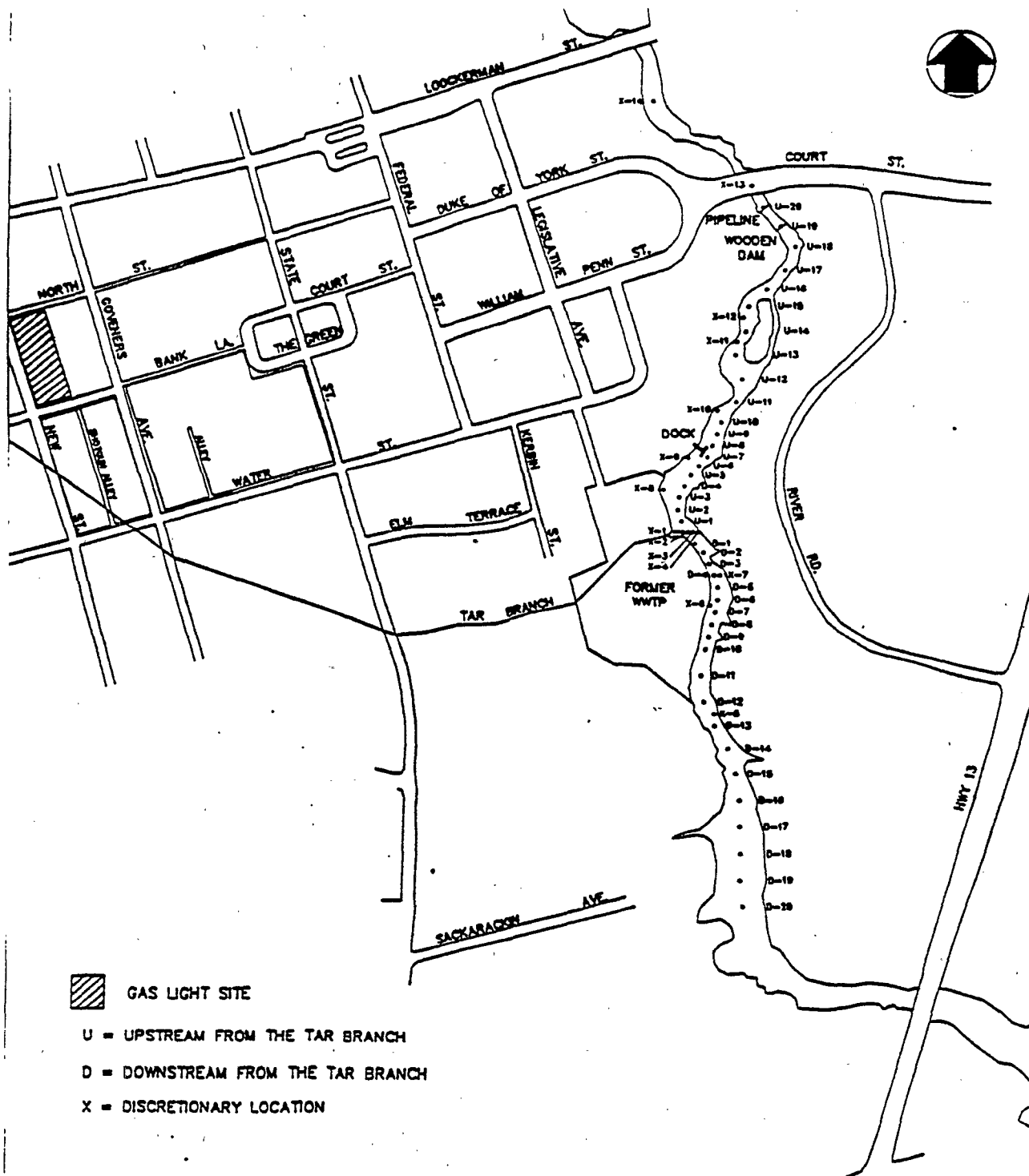
Dotted line shows course of the Tar Branch, a covered culvert that drains into the St. Jones River. Boxes indicate test sites.



- TAR BRANCH
- ☐ PATHWAY ANALYSIS BORING LOCATIONS
- ☐ SURFACE WATER SAMPLING LOCATIONS

SAMPLING LOCATIONS ON THE ST. JONES RIVER

Dots and notations show dozens of sites along St. Jones River, both above and below the Tar Branch outlet, where water was sampled for compounds from the site.



STUDY REMARKS ABOUT TAR BRANCH & ST. JONES RIVER

1.) "No surface water bodies exist on the site or immediately adjacent to it. At its closest point, the Tar Branch, which is a small urban storm sewer, is approximately 150 feet southwest of the site, flowing in a southeasterly direction and discharging into the St. Jones River. The St. Jones is a tidally influenced water body which runs in a north-south direction to the Delaware Bay. At its nearest point, the St. Jones is approximately 2,500 feet east-southeast of the site. Extensive data gathered during the pathway analysis and the environmental assessment of the St. Jones River show that neither the Tar Branch nor the St. Jones River have been detrimentally impacted by the site. The sediment in the St. Jones River has been shown to contain numerous contaminants from urban sources, which were noted both upstream and downstream of the inflow from the Tar Branch. Benthic organisms found in the river are representative of aquatic habitats like the St. Jones River and contaminants found in the sediment were not toxic to indicator organisms." (Taken from page 2-14 of the Feasibility Study.)

VII. BASIS FOR CUC POSITION ON KEY REMEDIATION ISSUE

ISSUE: Whether Dover Gas Light Site compounds have reached Monitoring Well 13 near the St. Jones River by means of a slug of material that was spilled years ago, or whether there is a preferential pathway in the geology that allows Dover Gas Light Site compounds to go undetected at wells closer to the site, but then become detectable at Well 13.

POSITION: There is no evidence to support these theories. There is evidence that points to other sources and causes off-site. This is supported by chemical "fingerprint" tests.

COMMENTARY: There are State underground tank records showing that leaks from storage tanks of heating oil for buildings in the Capitol complex and gasoline at the National Guard Armory are causing the contamination readings at Well 13 and others nearby. Chemical "fingerprint" tests of samples confirm that the compounds found in the area of this well are not from a source similar to the site. This evidence renders moot the theories of preferential pathways in the geological structures or a long-ago "slug" of material that has some remaining effect.

(See documentation that follows)

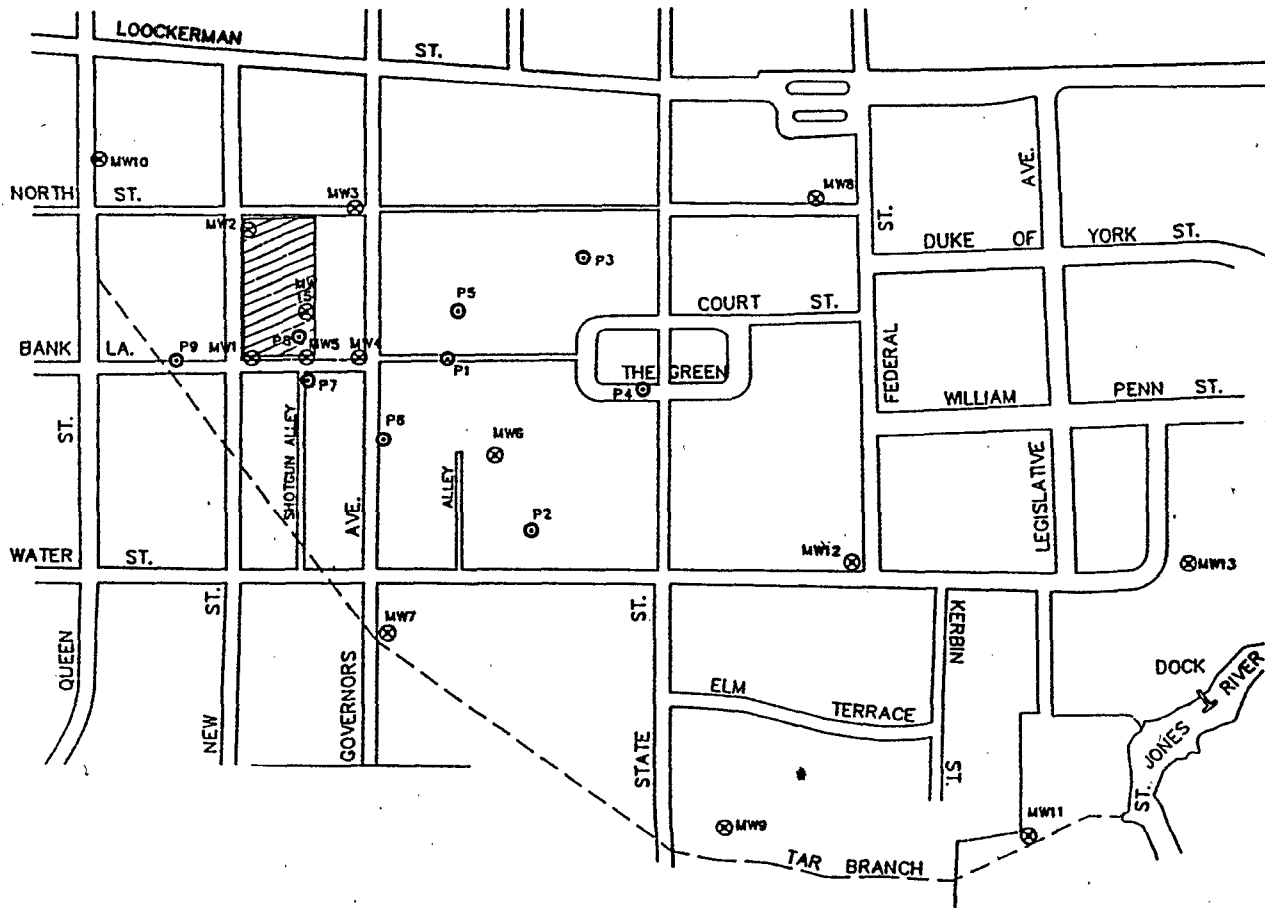
STUDY REMARKS ABOUT SLUG THEORY

1.) "The slug theory, as proposed by the EPA, relates to an oil tank overfill that is alleged to have occurred more than 45 years ago during the latter period of operation of the former manufactured gas plant. It has been suggested in comments referring to the delineation of the extent of contamination that petroleum hydrocarbon contaminants may have been released from the site as a "slug" during the period of time the former manufactured gas plant was in operation. DNREC suggests that evidence of such an event may be found in the reference to a fuel oil spill described in a deposition from an individual who was familiar with the former plant. The deposition does not provide specific data characterizing the magnitude of this release nor does the deposition provide information regarding remedial activities, if any, that may have occurred following the spill. Therefore, it is not possible to speculate if the contaminants from the spill may have migrated to the Columbia Aquifer, much less whether there is any lasting impact from this one-time event." (Taken from page 2-10 of the Feasibility Study.)

2.) "The [chemical fingerprint] data suggest that impact to ground water east of the site are variable, indicating that multiple contaminant sources are impacting the ground water." (Taken from page 24, Phase III Ground Water Evaluation Report.)

SLUG THEORY & PREFERENTIAL PATHWAY TO WELL 13?

Arrow points to monitoring well 13, more than 2,000 feet from the Dover Gas Light Site. Solid dots show Ground Water Phase III study wells that show there is no preferential pathway in the geology by which compounds present there could have migrated from the site. Instead, chemical "fingerprints" of the well samples show that compounds at well 13 do not match those at the site.



VIII. BASIS FOR CUC POSITIONS ON KEY REMEDIATION ISSUE

ISSUE: What part(s) of the area CUC feels it is directly responsible for.

POSITION: CUC believes it has defined the area where constituents from the Dover Gas Light Site begin and end, using the evidence from monitoring wells and chemical "fingerprint" tests. The additional off-site areas that have been contaminated from other sources, are also indicated by monitoring wells and chemical "fingerprint" tests. Remediation costs should be apportioned among the PRPs according to these patterns.

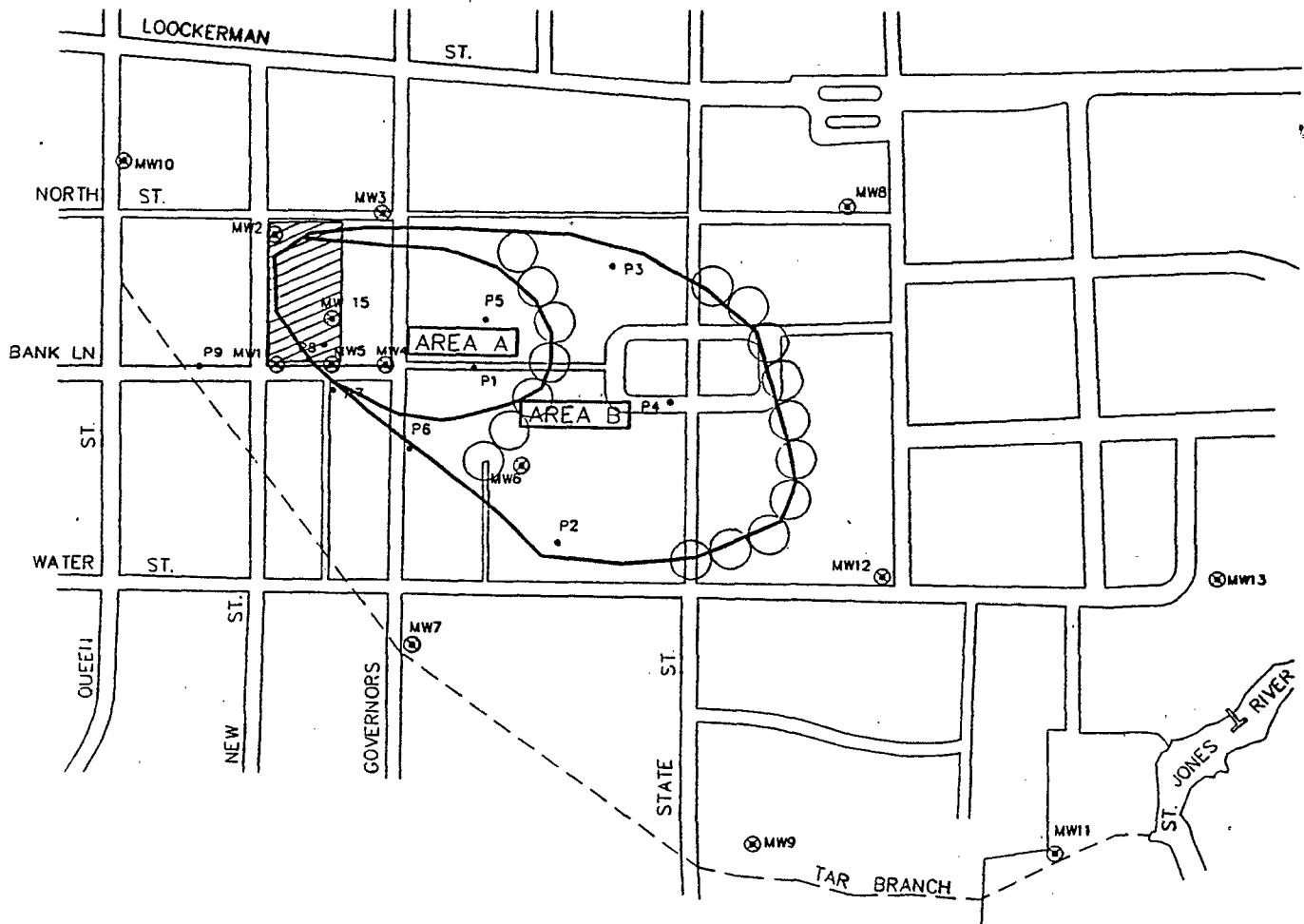
COMMENTARY: The map (next page) shows Area A, which CUC believes defines the area containing affects by compounds from the Dover Gas Light Site. Area B defines the areas extending toward the State Capitol Complex that is most likely to contain some effects from the site and major effects from other sources, especially the dry cleaning operations. The contaminated area beyond A and B is primarily from State property sources. Of course, all of these will be addressed during the remediation process, but Area B may be only partially the responsibility of CUC and the area beyond it is more properly the responsibility of the State of Delaware.

The details of CUC's position concerning the area of responsibility were developed before EPA issued its preferred plan. There appears to be no substantive difference between CUC and EPA in the physical area defined for action by CUC, and CUC accepts the EPA plan in that regard.

(See map, next page)

AREAS OF RESPONSIBILITY FOR PRPs

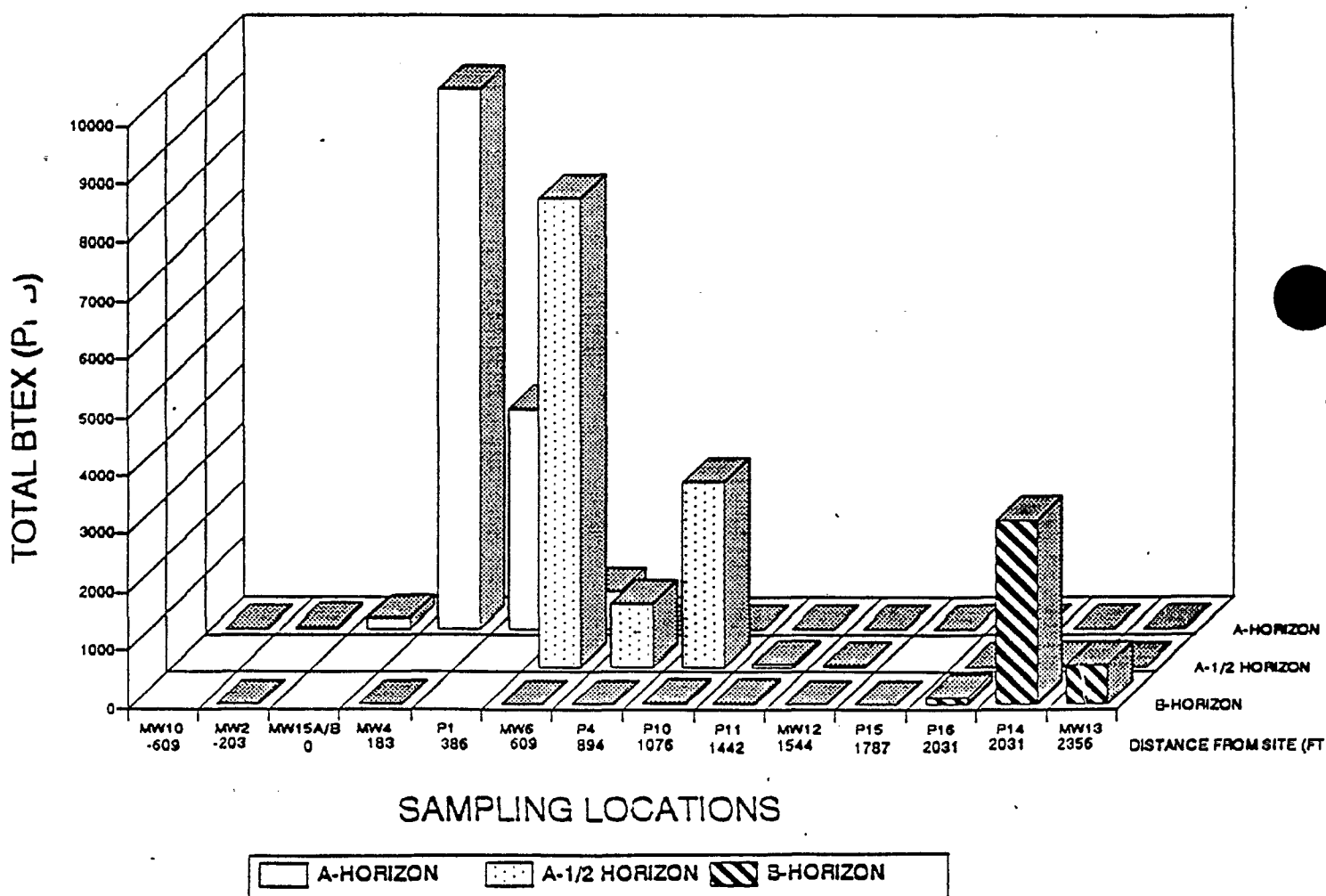
Area A is maximum responsibility of CUC. Its easternmost edge corresponds to well tests which show PAHs which are found on site. Area B, where much of the chlorinated solvents are found, is partially affected by the site, but mostly the responsibility of dry cleaning company. The rest of area under the Capitol Complex and toward the Saint Jones River is the responsibility of the State of Delaware. Circles show proposed well sites for hydraulic containment.



SPATIAL SEPARATIONS OF BTEX IN RELATION TO THE SITE

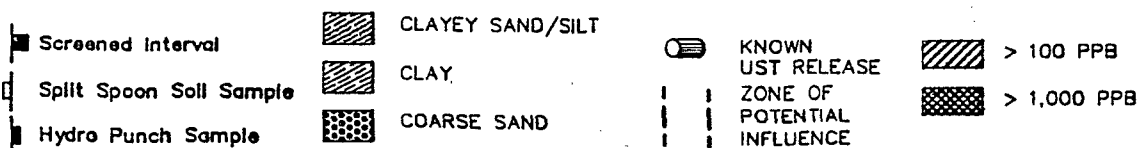
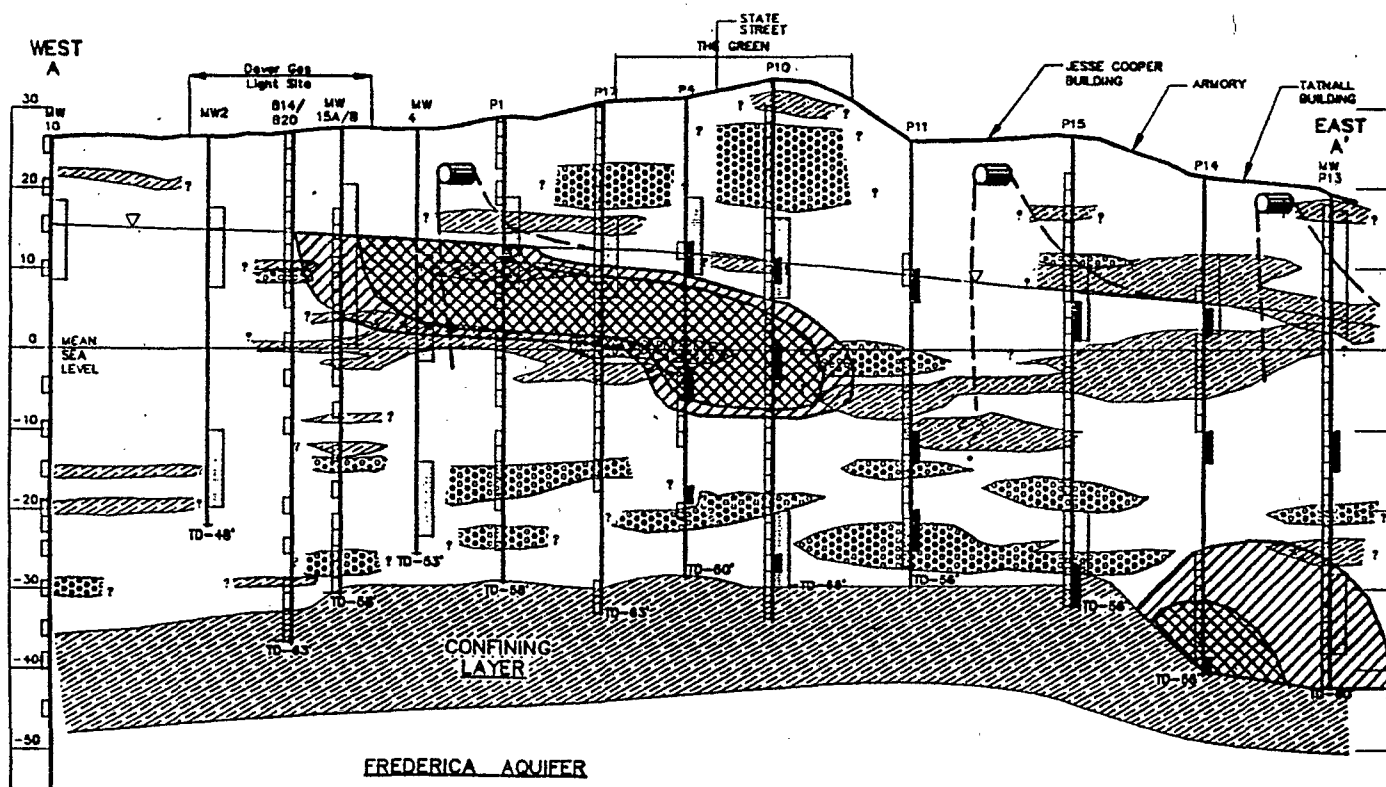
The spikes shown result from measurements at the differing locations east of the site at three different depths. They correspond to leaking tank locations at two different dry cleaning sites and three leaking tanks on State property. Results are from the Ground Water Phase III study.

SPATIAL DISTRIBUTION OF TOTAL BTEX



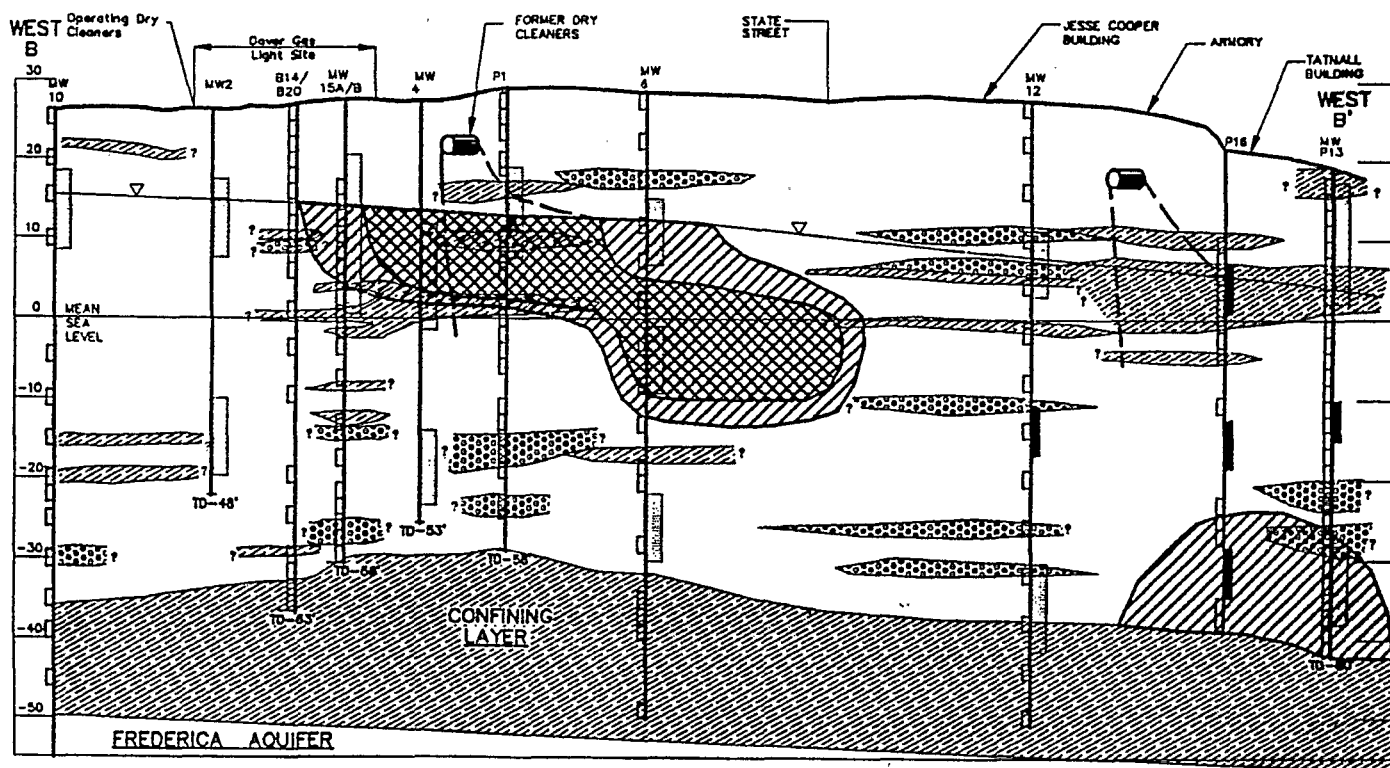
VERTICAL EXTENT AND SPACING OF BTEX IN GROUND WATER "A-A" HORIZON

Groundwater plumes show clear relationship to the site at left. The effects of dry cleaning fuel tanks and the result of leaking State fuel tanks are shown toward the right. Results are from the Ground Water Phase III study.



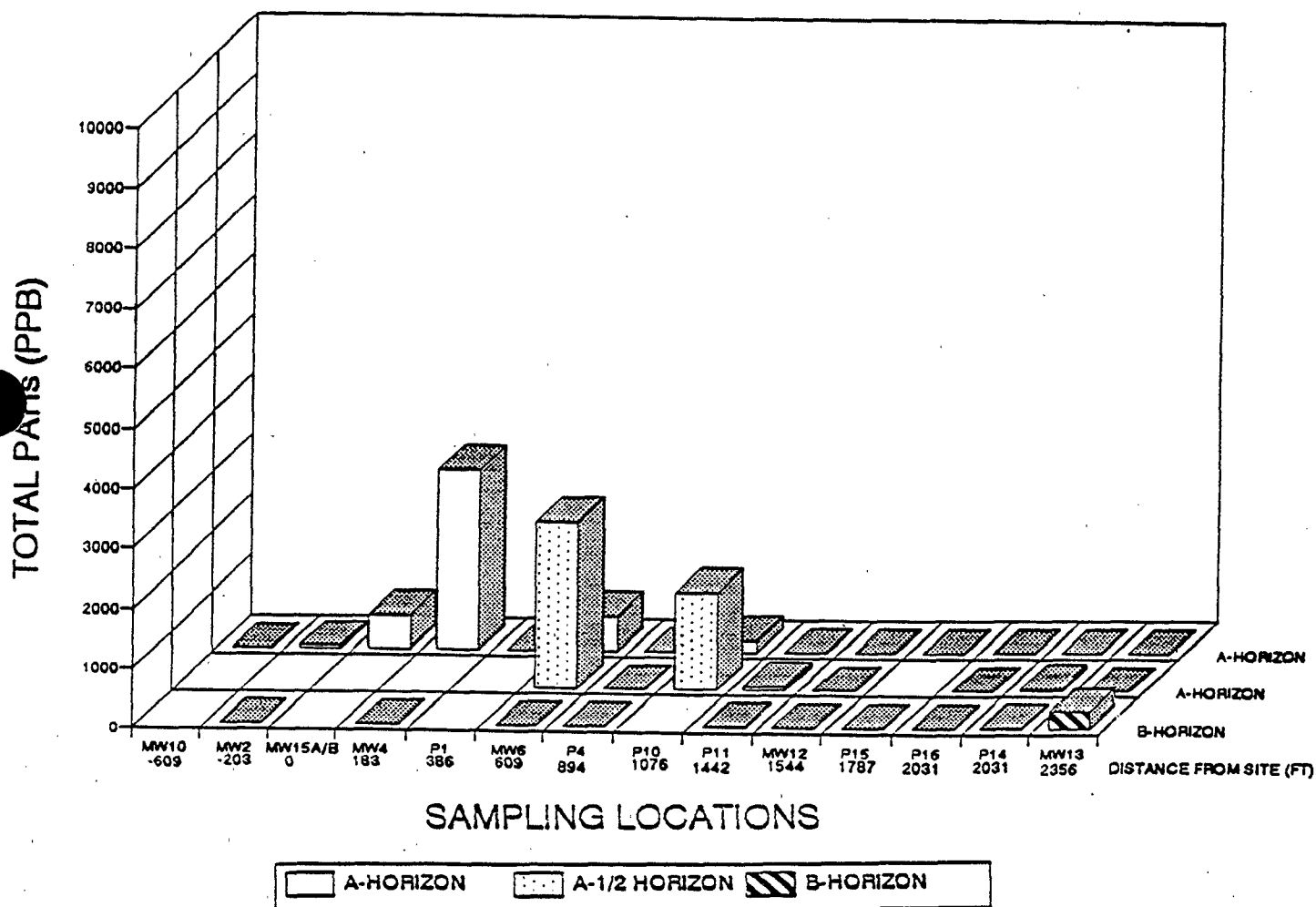
VERTICAL EXTENT AND SPACING OF BTEX IN GROUND WATER "B-B" HORIZON

Groundwater plumes show clear relationship to the site at left. The effects of dry cleaning fuel tanks and the result of leaking State fuel tanks are shown toward the right. Results are from the Ground Water Phase III study.



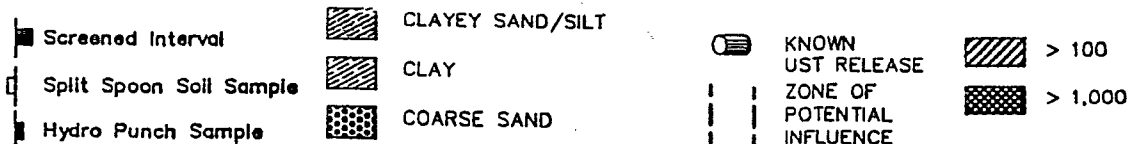
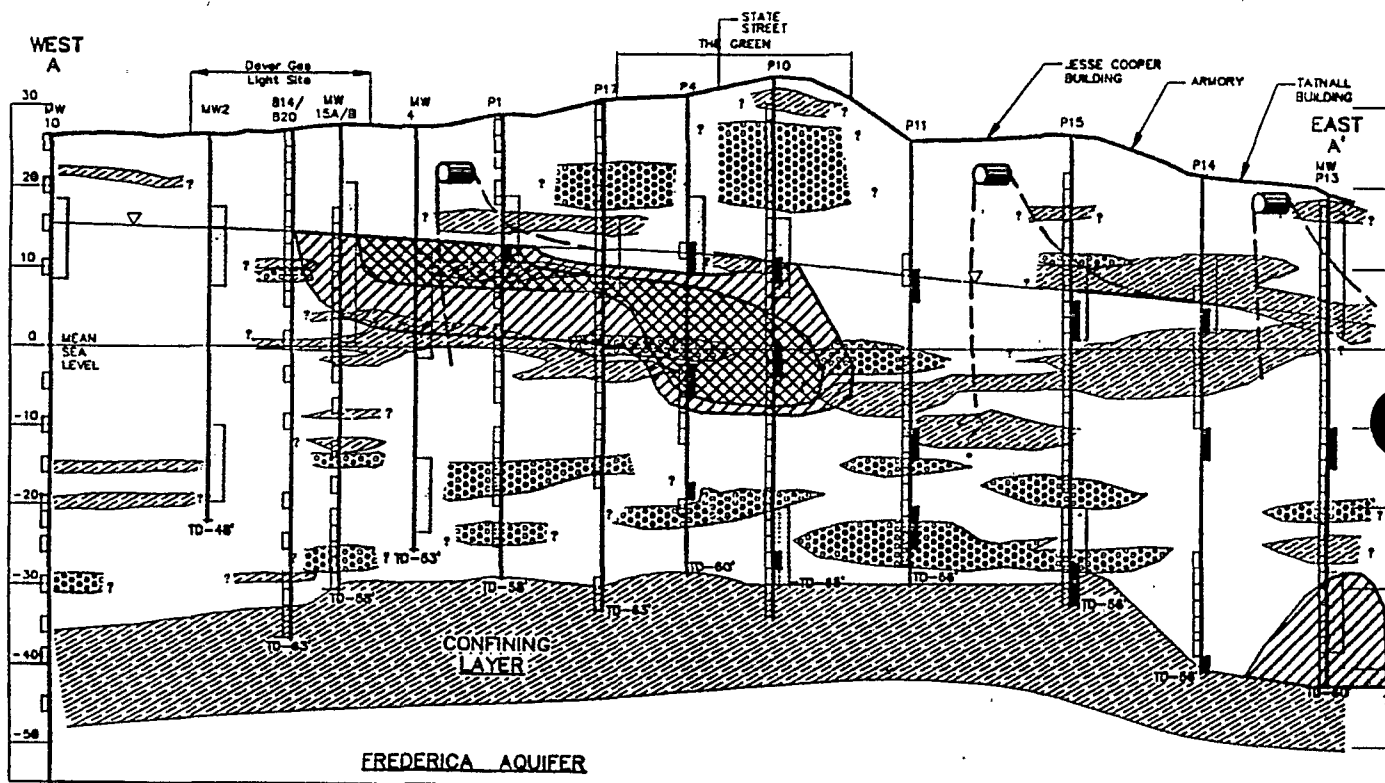
SPATIAL SEPARATIONS OF PAHs IN RELATION TO THE SITE

As with distribution of the BTEX contaminants, the spikes caused by presence of PAHs correspond to releases of fuel from the dry cleaning sites and, at right, to leaks from the State-owned tanks at three different depths. Results are from the Ground Water Phase III study.



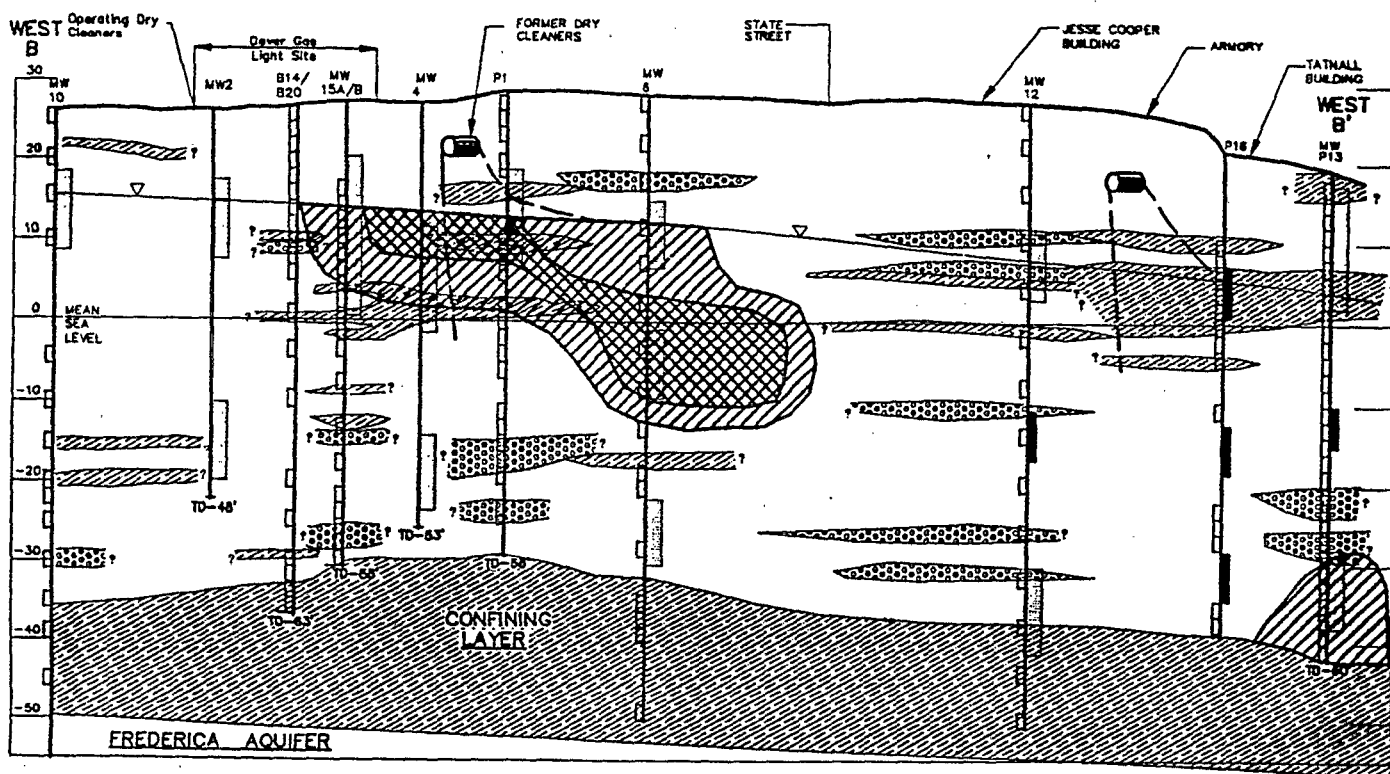
VERTICAL EXTENT AND SPACING OF PAHs IN GROUND WATER "A-A" HORIZON

Groundwater plumes show clear relationship to the site at left. The effects of the dry cleaning fuel tanks and the result of leaking State fuel tanks are shown toward the right. Results are from the Ground Water Phase III study.



VERTICAL EXTENT AND SPACING OF PAHs IN GROUND WATER "B-B" HORIZON

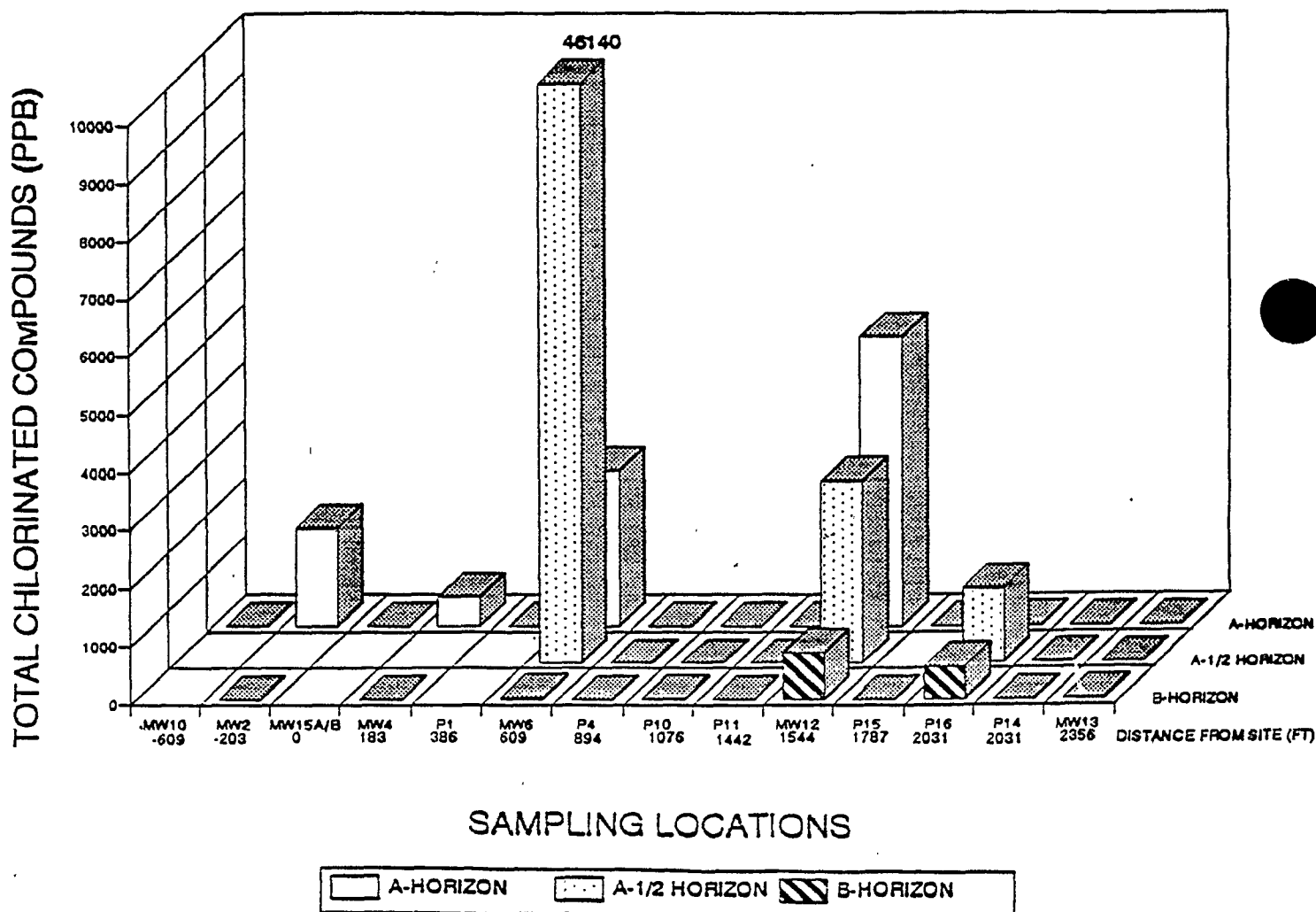
Groundwater plumes show clear relationship to the site at left. The effects of the dry cleaning fuel tanks under The Green, and the result of leaking State fuel tanks are shown toward the right. Results are from the Ground Water Phase III study.



- | | | | |
|---------------------------|--------------------|-----------------------------|-----------|
| ■ Screened Interval | ▨ CLAYEY SAND/SILT | ○ KNOWN UST RELEASE | ▨ > 100 |
| □ Split Spoon Soil Sample | ▨ CLAY | ZONE OF POTENTIAL INFLUENCE | ▨ > 1,000 |
| ■ Hydro Punch Sample | ▨ COARSE SAND | | |
| ▽ WATER TABLE | | | |

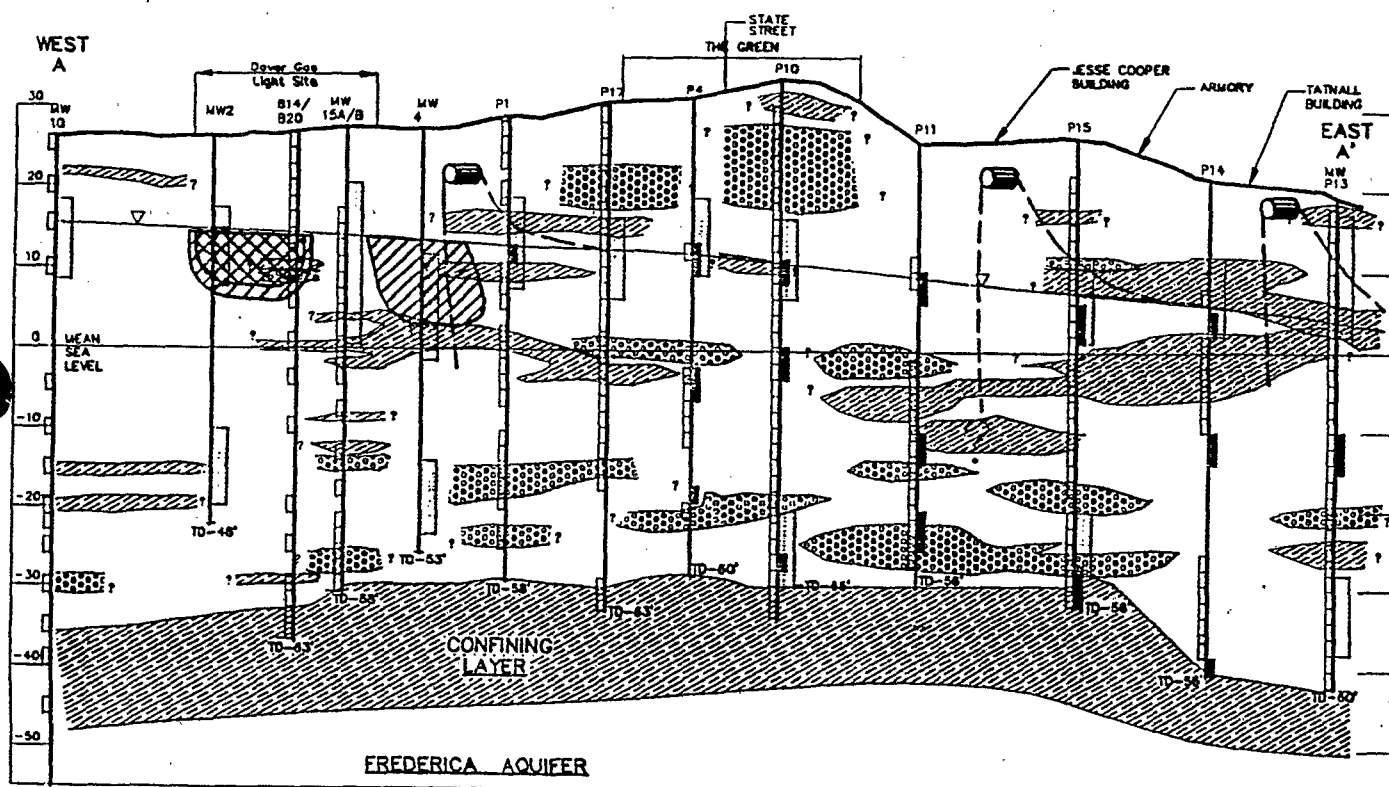
SPATIAL SEPARATION OF CHLORINATED COMPOUNDS

Spikes of chlorinated solvents show relationship to site, at left, as a result of dry cleaning solvent tank leaks. Spike shown on Dover Gas Light Site is coming from the existing dry cleaning site to the north. Larger spikes at center and right are the result of solvent leaks at the former drying cleaning site south and east of the Dover Gas Light Site. Solvent leaks have affected even the State properties at right. Measurements are from three horizons. Results are from the Ground Water Phase III study.



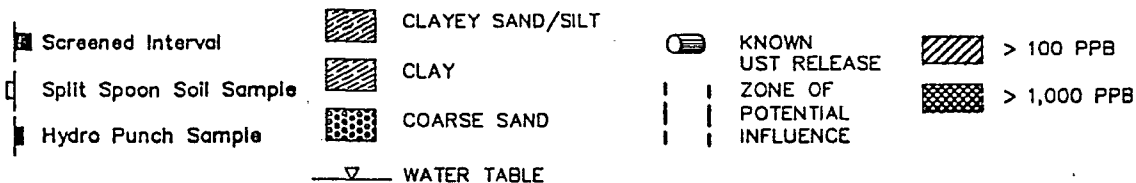
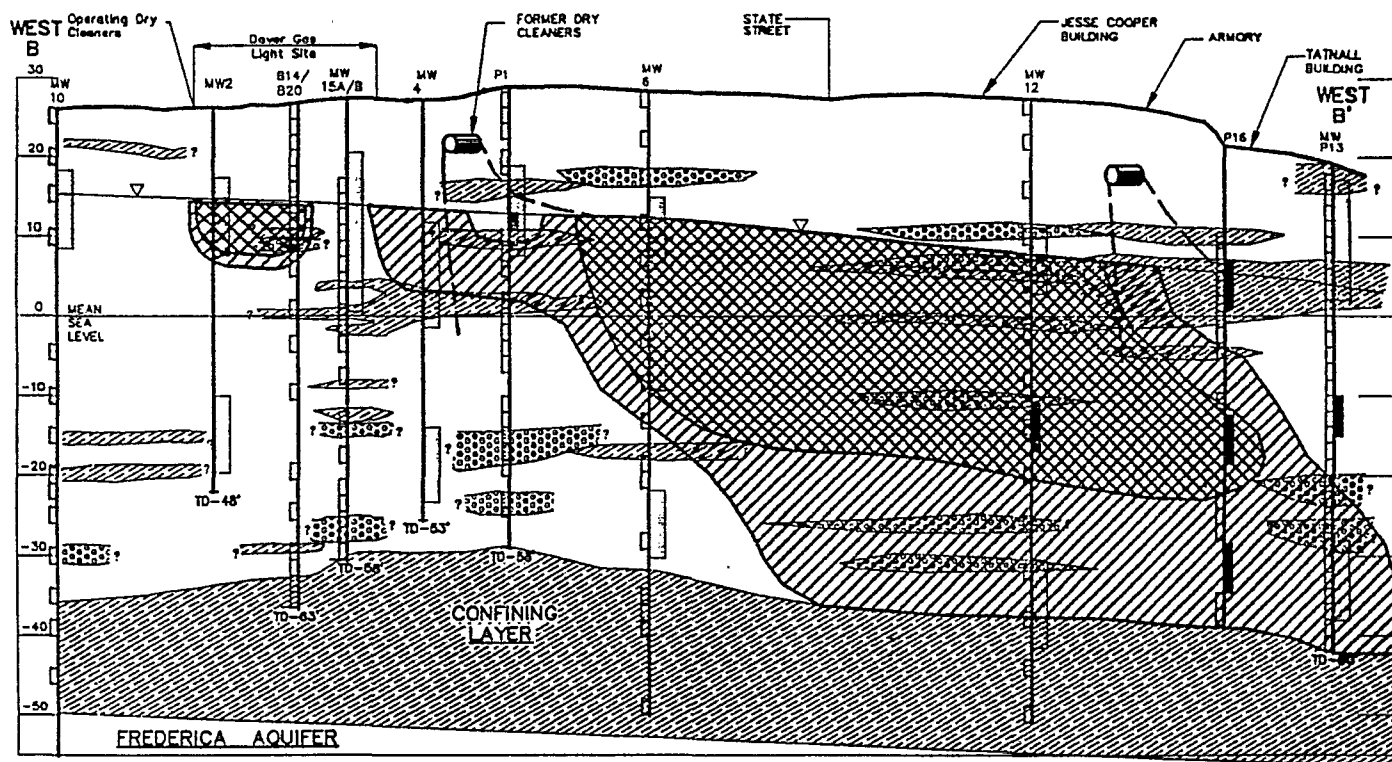
VERTICAL EXTENT AND SPACING OF CHLORINATED COMPOUNDS "A-A" HORIZON

Plume of chlorinated solvent under the Dover Gas Light Site comes from the existing location of the dry cleaners to the north. Plume of chlorinated solvent just east of the Dover Gas Light Site is from the former location of the dry cleaners. In this horizon, no solvent contamination is reaching under the State properties. Results are from the Ground Water Phase III study.



VERTICAL EXTENT AND SPACING OF CHLORINATED COMPOUNDS "B-B" HORIZON

In this horizon, plume of chlorinated solvent from the former dry cleaners location has affected almost all of the area east of the Dover Gas Light Site under the State properties. Results are from the Ground Water Phase III study.



APPENDIX A

CONCLUSIONS OF REMEDIAL INVESTIGATION REPORT

AR308812

8.0 FINDINGS AND CONCLUSIONS FOR THE DOVER GAS LIGHT SITE RI REPORT

The Remedial Investigation (RI) of the Dover Gas Light Site has been completed consistent with the approach and methods described in the approved RI/FS Work Plan (October 8, 1991) and supplemental Work Plans (e.g., Environmental Assessment of the St. Jones River, Phase II Ground-Water Investigation). The various data gathering activities comprising this RI were systematically performed to ensure that all data gaps have been filled and sufficient data exists to prepare a comprehensive feasibility study (FS) report. Details of each RI data gathering activity including the presentation of findings and results have been previously discussed (Sections 3 and 4). The following describes the major findings and conclusions of this RI:

1. Dover Gas Light Site - The Site which occupies the western half of the city block bounded by North Street, New Street, Governors Avenue, and Bank Lane in Dover, Delaware contains buried debris and other materials resulting from the operation and demolition of a former manufactured gas plant (MFG). Based upon on-site geophysical testing and soil boring sampling and analysis, the Site is contaminated with waste and soil containing volatile non-halogenated organic compounds (VOCs), semivolatile organic compounds, principally polynuclear aromatic hydrocarbons (PAHs), and metals. The sources of on-site waste are not fully contained, although remnants of some structures (foundations for gas holders or buildings, subsurface vaults) may exist on the Site. Historical information suggests that debris resulting from the demolition of the former MGP may have been buried in subsurface structures which are believed to be above the water table. Since the former MGP operated from the 1860's to 1948 when it was demolished, the subsurface source(s) of waste may have been releasing contaminants to the environment for substantially longer than 40 years.

2. On-Site Soil Contamination - Contaminants from sources on-site have migrated primarily in a vertical direction, through the vadose (unsaturated) zone to the water table which is approximately 15 feet below the Site. Contaminant levels are most significant above the water table at locations near the former gas holders as characterized by the reasonable maximum exposure (RME) concentration of 1,471 mg/Kg for total BTEX compounds (benzene, toluene, ethylbenzene, total xylenes) and 10,100 mg/Kg total PAH compounds. Significant heavy metals found in on-site soils at concentrations above State of Delaware background levels (see Table 6-1) include barium (1,230 mg/Kg), chromium (60.9 mg/Kg), lead (1,460 mg/Kg), manganese (264 mg/Kg), and mercury (0.573 mg/Kg). Contamination in on-site soil is localized to shallow depths, but has migrated laterally within the saturated zone. *Of the 6 samples collected at depths greater than 25 feet, only one sample exhibited contamination above method detection limits. This sample was collected at the base of the aquifer and is overlain by uncontaminated soil, based upon analytical sampling.*

Mechanisms controlling the migration of site-related contaminants include leaching of water-soluble components and mass diffusion of liquid or semi-solid wastes through the unsaturated soil environment. Vapor phase migration of contaminants in the unsaturated zone of the soil is not considered a primary transport mechanism. Migration of *significant levels of site-related* contaminants has not extended to the lower aquifers. *It has been noted that benzene was detected in well MW12C, which is screened in the Frederica, at an estimated level of 2.3 ppb. While the presence of this compound in the Frederica suggests some level of interconnection, this sample is anomalous when compared to other data from the same horizon and is below the MCL for drinking water. On April 11, 1993, Chesapeake Utilities notified DNREC that it will perform ground-water testing in well clusters 12 and 13.*

Physical transport of on-site contaminated soils via surface water runoff mechanisms has not caused soil in areas adjacent to the Site to be contaminated. Once source-related contaminants migrate vertically to the water table, hydrogeologic and geochemical factors such as ground-water flow direction and velocity, soil permeability, and physical/chemical interactions between the soil and the contaminants (sorption, partitioning) control the lateral and vertical migration of site-related contaminants in the Columbia Aquifer. Organic compounds such as benzene, which are moderately soluble in water do not readily sorb to soil particles (e.g., clay) and tend to migrate with the local ground-water flow. By contrast, organic compounds such as PAHs, which are only slightly soluble in water and tend to sorb tightly to soil particles, migrate at very slow rates with respect to the local ground-water flow.

3. Off-Site Soil Contamination - Soil in areas within 600 feet of the Site have been impacted by site-related contaminants and contaminants from background sources. Off-site soil contamination is localized within more permeable zones at or immediately below the water table. Contaminant levels in off-site soil from above the water table are characterized by the RME concentrations of 0.975 mg/Kg for total BTEX compounds (benzene, toluene, ethylbenzene, total xylenes), 166 mg/Kg for total PAHs (polynuclear aromatic hydrocarbons) and 0.963 mg/Kg for chlorinated organic compounds. No significant inorganic concentrations were found in off-site soils. PAH contamination in the soil extended to locations approximately 400 feet east of the Site.

Site-related contaminants are generally considered to be BTEX and PAH compounds. Chlorinated organic compounds are not related to the Site and are the result of off-site background sources of contamination. BTEX, PAH and chlorinated compounds were detected in both on- and off-site soils. *Although BTEX and PAHs have been detected off-site, background sources have contributed a majority, and in some locations are the sole sources, of the BTEX and PAHs present.*

The probable mechanism controlling the migration of site-related contaminants to these off-site areas is ground-water transport, with little or no contamination in the vadose zone. The vertical extent of soil contamination is limited to specific zones in the Columbia Aquifer which are accessible to contaminant fluxes and are delineated by semi-confining layers or geologic strata with reduced permeability. The limits of lateral migration are controlled by hydraulic gradients and chemical or biological interactions between the soil and contaminants, which tend to retard the rate of contaminant migration to velocities which are significantly less than the overall ground-water flow velocity.

Since contaminants in off-site soils are located in the saturated zone and are in equilibrium with the ground water, the soil is expected to continue to release small amounts of organic compounds to the ground water in the future.

4. Off-Site Sources of Contamination - The area surrounding the Dover Gas Light Site is a highly urbanized downtown portion of the City representing development for residential, commercial, and municipal (city, state, and federal) applications. Many properties in this area either currently or formerly included activities which involved the use and storage of hazardous or environmentally sensitive materials. Locations which could have used or stored these types of materials include gas stations and service garages, dry cleaners, furniture stripping firms, automobile painting shops, buildings which stored fuel oil in underground tanks, and businesses which used bulk chemicals or stored wastes in 55-gal drums. Public information indicates that over 30 potential sources of background environmental contamination exist in the portion of Dover between the Site and the St. Jones River.

Many of the properties in the area of Dover east of the Site either have or had underground tanks which were relatively old, greater than 20 years, uncoated, without cathodic protection systems and unlined. As such, the potential that some of these tanks may have leaked petroleum hydrocarbon fuels, chlorinated solvents, or other hazardous materials is great. Currently, DNREC is investigating at least one location, approximately 500 feet southeast of the Site, that may have been a source for the release of chlorinated solvents and petroleum hydrocarbon fuels. This information clearly suggests that the area to the east of the Site has been impacted by multiple sources of contamination. The ground-water contamination plume that exists in this portion of the City is the culmination of releases from multiple sources. Fuel oil or diesel fuel contains numerous organic constituents (see Table 3-14a), such as *di-aromatic* PAH compounds (*napthalene, etc.*), which are indistinguishable from constituents that may be found in wastes associated with former MGP Sites. As a result, the delineation of the extent of contamination from the Dover Gas Light Site cannot be positively established and remediation, if warranted, could well involve multiple responsible parties.

5. Localized Hydrogeology - The fate and transport of contaminants originating from source materials on the Site, is controlled by the local hydrogeology. The uppermost phreatic aquifer, the Columbia Aquifer, is comprised of interbedded, laterally discontinuous clay, clayey sand, sand, and granular sand horizons. These horizons possess a wide range of permeabilities which can channel ground-water flow and contaminant migration in the granular sand layers above low permeability clayey horizons. The deeper portions of the Columbia Aquifer *in the vicinity of the Site* are *not significantly* affected by site-related contamination (PAH compounds). Some chlorinated compounds have migrated to the base of the aquifer in the vicinity of well clusters 6 and 13, *chlorinated compounds* are not site-related as *acknowledged by DNREC*. *Although BTEX compounds have migrated to the base of the aquifer in the vicinity of well clusters 6 and 13, total BTEX is contributed to significantly by and acknowledged background source in the vicinity of well cluster 6. The source of BTEX in well cluster 13 is the subject of dispute resolution between DNREC and CUC.* The aquitard separating the Columbia Aquifer from the underlying Frederica and thicker aquitards separating the Frederica from deeper aquifers are of sufficiently low permeability to limit the downward migration of contaminants. *Low levels of benzene (i.e., below MCLs) have been noted in one well suggesting that limited hydraulic interconnection may be occurring in this area. The detection of benzene in this well may be an anomaly and will be resampled to confirm the presence of contaminants in this aquifer.* Multiple pumping tests and water level monitoring programs have shown a lack of *significant* hydraulic connection across the aquitard, *within the detection limits of industry standard hydrogeologic methods.* *Based on these hydrogeologic studies, it is concluded that the aquitard isolates significant levels of contamination to the uppermost aquifer.*

The uppermost water bearing zone, the Columbia Aquifer, generally flows in a east-southeasterly direction and partially discharges into the St. Jones River approximately 2,500 feet east of the Site. The Columbia Aquifer is not used as a potable water source, nor is it capable of sustaining pumping rates necessary for domestic or commercial applications. High quality drinking water for the City of Dover is pumped from the Cheswold and Piney Point Aquifers using pumps distributed throughout the City. *The City of Dover has determined that the Columbia Aquifer within the City limits cannot be used as a drinking water supply due to the low water yields as determined by test wells. In addition, preliminary results of testing in the northern portion of the City indicate that the Columbia Aquifer is not suitable as an industrial source of water due to high iron content and elevated levels of bacteria.* In the area of the City where contamination has been found in the Columbia Aquifer, no hydraulic interconnection *has been detected* between the Columbia Aquifer and much deeper drinking water aquifers; the nearest location where *significant* interconnection is possible in several miles upgradient of the Site.

6. Surface-Water and Sediment Contamination - There are no surface-water bodies on the Site or immediately adjacent to it. At it closest point, the Tar Branch, which is a small urban storm sewer, is approximately 150 feet southwest of the Site, flowing in a southeasterly direction and discharging into the St. Jones River. The St. Jones River is a tidally influenced water body which runs in a north-south direction to the Delaware Bay. Extensive data gathered during the Pathway Analysis and during the Environmental Assessment of the St. Jones River show that neither Tar Branch nor the St. Jones River have been detrimentally impacted by the Site or other sources. The sediment in the St. Jones River has been shown to contain numerous contaminants from urban sources, which were noted both upstream and downstream of the inflow from the Tar Branch. *The study findings show that remediation of the sediments in the river is not warranted.* Benthic organisms found in the River are representative of aquatic habitats like the St. Jones River and contaminants found in the sediment were not toxic to indicator organisms.

7. Ground-Water Contamination - The upper *portions* of the Columbia Aquifer have been impacted by the Dover Gas Light Site. Confined aquifers below the Columbia Aquifer, including the Frederica, Cheswold and Piney Point Aquifers, *do not appear to* have been *significantly* affected by contaminants in the Columbia and there is no reason to believe that these lower formations will be impacted in the foreseeable future. The total concentration of BTEX compounds detected in ground water immediately downgradient and adjacent to the Site (i.e., monitoring well 4A) is 3,310 ug/L and the total concentration of PAH compounds in MW4A is 4,811 ug/L. These ground-water contaminant levels decrease rapidly within a distance of 600 feet east from the Site, where background sources of contamination have a significant effect on the ground-water quality.

Although BTEX compounds have been detected in the ground water at distances greater than 600 feet from the Site, their presence seems to be due to numerous other *known or suspected* sources located between the Site and these monitoring locations. BTEX compounds have been found at monitoring well MW6A ½, which is approximately 600 feet downgradient of the Site at concentrations of 8,350 ug/L, and PAH compounds have been detected at the same location at concentrations of 6,350 ug/L. *These elevated levels* indicate that background sources of contamination are clearly impacting the ground-water quality in the vicinity of well *cluster* 6.

The Agencies have suggested that evidence of a slug event may be found in the reference to a fuel oil spill in an uncorroborated depositions from a former employee. The deposition does not provide specific data characterizing the magnitude of this release nor does the deposition provide information regarding remedial activities, if any, that may have occurred following the spill. Therefore, it is not possible to speculate if the contaminants from the spill

may have migrated to the Columbia Aquifer, much less whether there is any lasting impact from this one-time event.

It has also been suggested that the data collected at P1 provides evidence of a slug of contamination. Although the total BTEX level is slightly higher at P1 than MW4, the concentration levels are similar enough to be considered within sampling and analysis variabilities. Therefore, it is likely that the source(s) of contamination affecting MW4 has impacted P1 to nearly the same extent. It is unlikely that a slug release would exhibit similar contaminant levels at P1 and MW4. Comparing the naphthalene concentration at MW4A (3,990 ug/L) to the concentration of 1-3 ring polynuclear aromatic hydrocarbons at P1 (<200 ug/L) suggests that the migration of naphthalene may be significantly attenuated by hydrogeologic factors.

Chlorinated compounds, which are not site-related, have been detected in the vicinity of well cluster 6 at levels as high as 47,300 ug/L. No chlorinated organic compounds were detected in monitoring well MW4A which is located upgradient of well cluster 6 and immediately downgradient of the Site. Chlorinated compounds in the ground water are concentrated in specific areas north, northeast, and southeast of the Site and are not associated with the former MGP process or facility operations.

Site-related contaminants, including both soluble constituents and nonaqueous phase liquids (NAPLs), have intercepted the ground water beneath the Site and have migrated vertically and southeasterly in the general direction of the local ground-water flow. Semi-confining clay layers in the sand aquifer influence and inhibit vertical migration of contaminants and create vertically limited (relatively distinct) zones of contamination in the Columbia Aquifer. The extent of lateral migration is defined by specific physical and chemical characteristics of the waste, which cause the material to partition or fractionate into discrete chemical constituents as it migrates. For example, benzene, a relatively water soluble volatile organic compound, does not effectively sorb to organic soil particles, and therefore its lateral migration is not significantly attenuated by interactions with the soil. Benzene has been found in a monitoring well 2,000 feet east of the Site although its presence is likely to be influenced by other sources of organic contamination in the area. PAH compounds on the other hand, including naphthalene which is one of the more water soluble PAHs, tend to sorb to soil particles thereby attenuating the rate of migration to velocities that are 1 or 2 orders of magnitude less than the velocity of the ground water. Because the PAHs tend to migrate very slowly through geologic materials and because of the relatively low permeability of the Columbia Aquifer, the extent of PAH contamination is much more limited than the range of VOC contamination. Site-related PAHs extend approximately 600 feet downgradient of the Site, although other sources of PAH contamination such as releases of petroleum hydrocarbon fuels from underground tanks may have influenced these contaminants as well. Naphthalene

has been identified in well MW13B, however, because of the limited migration *capability* of naphthalene, it is unlikely that the Site is a contributing source of contamination to well cluster 13.

Several chlorinated volatile organic compounds were also found in the ground water on site and downgradient of the Site. Realizing that the discovery and subsequent industrial use of chlorinated solvents only occurred during the period of time corresponding to later stages of the operation of the former MGP and since coal gasification would not have created chlorinated materials as a by-product, it is concluded that the chlorinated compounds found in the ground water originated from other identified local sources.

8. Risk Assessment Summary - The Dover Gas Light Site and the surrounding areas which have been impacted by site-related contaminants, do not pose a significant human health or environmental risk based on current land use patterns. Contaminated soil is subsurface and covered by 1-3 feet of fill material. Therefore, exposure would only occur if an intrusive activity such as excavating for building construction or utility work is performed. Even in this case, the exposure period would be relatively short and since the area surrounding the Site is nearly completely developed for residential and commercial purposes and may be of archaeological significance, substantial excavation in the contaminated area is unlikely.

Risks associated with exposures to contaminated ground water are not likely because the permeability of the Columbia Aquifer results in very low water yields causing the aquifer to be insufficiently productive for either domestic or industrial applications. In addition, institutional controls, such as permitting requirements controlling the installation of water wells in the State and the City of Dover, and the readily available supply of high quality potable water at a low cost through the City's distribution system, cause the installation of a well in the Columbia Aquifer to be impractical and therefore the risk to be nonexistent. Nonetheless, exposure and theoretical risks associated with hypothetical contact with contaminated ground water have been calculated and appear in Section 7.

The risk assessment evaluated non-carcinogenic hazards and carcinogenic risks for 36 combinations of several media, receptors, scenarios, and pathway. The media, receptors, scenarios, and pathways were as follows:

Media: Ground water, St. Jones River surface water, St. Jones River sediment, on-site soil, and off-site soil.

Receptors: Residential adult, residential child, recreational adult, recreational child, adult museum visitor, child museum visitor, commercial adult museum worker, commercial adult state worker, commercial adult utility worker, and commercial adult contract worker.

Scenarios: *Drinking water, showering, bathing, watering the lawn, washing trucks, fishing, wading, visiting the museum, working at the museum, planting a tree, constructing a building, and repairing utilities.*

Pathways: *Ingestion, inhalation, and dermal absorption.*

Table 8-1 summarizes the hazard indices and risks for the 36 combinations.

None of the combinations involving on-site or off-site soil exhibited elevated hazards or risks. The only combinations with elevated hazards and risk involved exposure to compounds in ground water. There were elevated hazards and risks from fish ingestion and surface water dermal absorption, but they are modelled values based on ground-water monitoring data. The model used to establish surface water concentrations is considered to be conservative in its estimation of downgradient concentrations, because it does not include retardation of contaminants by decay or dispersion.

The ground-water routes with elevated hazards and risks included ingestion and dermal absorption for adults and children. The hazards and risks are associated with non-halogenated volatile organics, chlorinated volatile organics, semivolatile organics, and metals. The majority of the hazards (greater than 96 percent) are associated with the chlorinated volatile organics, which are not attributed to the manufactured gas plant operation.

9. Air Pollution - Currently, the Dover Gas Light Site is not an air pollution source because the contaminated media, including soil and ground water, are subsurface and are not exposed to ambient conditions. In the event that remediation is warranted and subsurface contaminants are exposed through mechanisms such as excavation or ground-water pumping, technology-based and institutional controls would be required to minimize contaminant releases to the air.

Historical information indicates that the former MGP may have been an air pollution source during its period of operation, albeit a minor one. The plant did have a stack which was used to emit flue gases from the combustion of coal for steam generation purposes only. No point source gaseous or particulate emissions were released as a result of the gasification process itself. The environmental fate of any fugitive emissions that may have occurred as a result of the gasification process would have long since degraded or dispersed since they would have been released to the environment well over 40 years ago.

10. Archaeological Significance - In compliance with Section 106 of the National Historic Preservation Act, investigations performed during this RI have concluded that the Site may contain remnants of structures from the MGP, which would be archaeologically significant if present. Additional on-site study will be necessary if on-site remediation is

warranted and if any such remediation requires the disturbance of the subsurface. Such additional studies would seek to identify potential archaeological resources on the Site, and to evaluate whether any impact upon these potential resources can reasonably be avoided.

The extent of urban development surrounding the Site will influence the selection of remedial alternatives, if remediation is warranted. The Site itself, as well as the neighborhood it is located in, is identified on the National Register of Historic Places as part of the Delaware State Museum Site. Therefore, future plans to remediate or develop the Site or adjacent areas would include considerations to avoid the unnecessary loss of historic information or to avoid altering the historic character of the area. However, notwithstanding the potential inclusion of the former MGP Site on the National Register, the area in which the Site is located is archaeologically significant. Specifically, the Delaware State Museum complex, adjacent to the Site on the east Site, includes buildings and a cemetery of historical significance.

11. Conclusion - In summary, the Remedial Investigation has shown that source materials associated with the former manufactured gas plant are located on the Site and have the potential to continue to release contaminants to the subsurface environment. On-site soil and shallow ground water have been impacted by contaminants from MGP wastes. Shallow ground-water contamination *related to the Site* has *been confirmed* approximately 600 feet beyond the Site boundary. The ground water in the area potentially impacted by the Site has also been impacted by releases from other background sources.

APPENDIX B

CONCLUSIONS OF PHASE III GROUND WATER EVALUATION STUDY

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5.0 CONCLUSIONS

The Phase III Ground-Water Evaluation Study was undertaken by Chesapeake Utilities Corporation during the summer of 1993 to fill data gaps identified by DNREC and EPA as a result of their review of the Remedial Investigation and Feasibility Study Reports. In particular, the Phase III Study characterized the hydrogeology and ground-water quality in the State Capitol Complex area between State Street and monitoring well cluster 13. The Phase III Study succeeded in providing additional data regarding the extent of site-related contamination and definitively demonstrated that background sources of contamination not associated with the Dover Gas Light Site are impacting the quality ground water in the Columbia Aquifer. The following summarizes the findings of the Phase III Study:

1. Hydrogeology

The Phase III Ground-Water Evaluation Study confirmed that the subsurface geology in the vicinity of the Site is characterized by interlayered and discontinuous lenses of granular sand and clay in a dominantly fine- to medium-grained sand matrix. A clayey horizon approximately 5 feet above mean sea level and approximately 9 feet below the water table appears to extend east and southeast from the Site for approximately 1,000 feet. Beyond this distance the clay horizon becomes more diffuse, deeper and less continuous. Other clay-rich sand and silt horizons were observed in the Columbia Aquifer but do not appear to play a significant a role in determining the hydrogeologic characteristics of the aquifer.

The fine- to medium-grained sand beneath the Site exhibits low permeability with hydraulic conductivity values ranging from $10E-04$ cm/s to $10E-06$ cm/s. These sand units have low water yields, with sustainable pump test rates less than 2 gallons per minute. Generally, a well that yields water at a rate of 2 gallons per minute or less cannot practicably be used for domestic or industrial applications, particularly in light of the readily available supply of potable water distributed by the City of Dover. The low permeability of the Columbia Aquifer is also significant when considering ground-water remediation. Because of the tightness of the Columbia Aquifer formation, an extensive and complex system of wells

would be necessary to either extract ground water for ex-situ treatment or introduce reagents for in-situ treatment.

Within the Columbia Aquifer, intermediate clay horizons have lower hydraulic conductivities than adjacent sand horizons. Between the Site and State Street, lower permeability clay horizons appear to effectively retard the downward migration of organic compounds that are denser than water, causing these ground-water constituents to be perched at intermediate levels within the Columbia Aquifer. East of State Street in the area of the State Capitol Complex where releases from underground tanks have been confirmed, clay-rich horizons are present, but these are more sandy and silty, and do not appear to have an impact on the migration of compounds of interest. This lack of retarding clay horizons is coupled with a downward hydraulic gradient to allow organic compounds to be distributed as deep as the base of the aquifer.

The Phase III Ground-Water Evaluation Study confirmed that ground-water flow from the Site is in an east-southeasterly direction. Releases from the Site or from background sources have been observed at downgradient monitoring points including MW4, P1, MW6, P4, P10, MW12, P16, P14, and MW13. Consistent with the ground-water flow regime, constituent concentrations tend to decrease west to east with increasing distances from the Site. However, higher than expected concentration levels were observed for various constituents (e.g., BTEX and PAH compounds) at monitoring locations downgradient of suspected background sources of contamination. The data from the Phase III Study confirms the suspicion that releases have occurred from underground storage tanks in the State Capitol Complex east of State Street and have impacted the local ground-water quality. This conclusion supplements and supports findings from earlier studies and is based on the analytical testing of ground-water samples obtained from the area between The Green and well cluster 13.

Ground-water flow data for the upper and lower portions of the Columbia Aquifer indicate that the flow beneath the Site and as far east as State Street is horizontal with no significant vertical component. East of State Street, a downward hydraulic gradient is measurable and becomes greater near well cluster 13 and the St. Jones River. It is believed

that the St. Jones River may be a factor causing this downward hydraulic gradient in the Columbia Aquifer. Contaminants released from background sources in the area east of State Street rapidly migrate to the base of the Columbia Aquifer and generally travel in a east-southeasterly direction consistent with the local ground-water flow direction. Because of the downward hydraulic gradient in the vicinity of the river and potential barrier effect caused by the low permeability river sediment, it is unlikely that any compounds in ground water detected at well cluster 13 are discharging into the river.

2. Contamination Distribution

Findings derived from the Phase III Study indicate benzene, toluene, ethylbenzene, and xylenes (BTEX) are present at elevated levels in two distinct areas, one between the Site and State Street and the other downgradient of several underground storage tanks (USTs) in the State Capitol Complex. The concentrations of BTEX compounds in the Columbia Aquifer tend to decrease from west to east consistent with increasing distances from the Site. However, this trend is reversed when the effects of one or more leaking USTs are realized, particularly in the area of the Capitol Complex.

PAH compounds are present at elevated levels in the soil and ground water in the same general areas as BTEX compounds, from the Site to approximately State Street and downgradient of underground storage tanks in the State Capitol Complex. Similar to the distribution of BTEX compounds, PAH levels generally tend to decrease west to east until the effects of releases from underground tanks are realized.

Chlorinated compounds are present at elevated levels in soil and ground water across much of the study area. DNREC and EPA have acknowledged that the Dover Gas Light Site is not the source of chlorinated compounds in the area. The distribution of chlorinated compounds exhibits two distinct plumes including one originating near the intersection of North and New Streets, upgradient of the Site, and extending approximately 1,600 feet to MW8A. The other distinct plume of chlorinated compounds originates from a former dry cleaning facility at 411 South Governors Avenue and extends approximately 2,000 feet east-southeast to well cluster 13.

At several locations, monitoring data obtained during the Phase III Study indicated the concentrations of BTEX, PAH, and chlorinated compounds changed substantially since the last monitoring event in 1991. In some cases, the concentrations increased during this period of time. Because there have not been any activities associated with subsurface materials or debris at the Dover Gas Light Site in more than 40 years, it is unlikely that the Site is the cause for these concentration increases in the Columbia Aquifer. It is likely that these concentration changes are the result of background sources of contamination in Dover.

The Phase III data also confirmed that there is not a preferential ground-water flow pathway between the A and B horizons in the vicinity of well cluster 12. In the vicinity of well cluster 12, the distribution of chlorinated compounds in the Columbia Aquifer is consistent in the A, A½, and B horizons considering the suspected source of these compounds, the local ground-water flow in the area, and the downward hydraulic gradient.

3. Background Contaminant Sources

The Phase III Ground-Water Evaluation Study confirmed that background sources of contamination, particularly in the area of the State Capitol Complex east of State Street have impacted the ground water in the Columbia Aquifer. Sources of BTEX and PAH compounds, generally the result of releases from underground storage tanks, include the Jesse Cooper Building, the Delaware National Guard Armory, and the Tatnall Building. In general, ground-water constituent concentrations decrease with increasing distances from the Site until the effects of these sources were realized. The Phase III Study also confirmed previous observations that the former Capitol Uniform and Linen facility at 411 South Governors Avenue released BTEX, PAHs and chlorinated compounds to the ground water.

In addition to the underground tanks listed above that are known to have leaked and impacted the ground water based on testing data, numerous other tanks are known to be currently in use or were used in the area. Many of these tanks are no longer in service and records documenting the removal or clean closure of the tanks and remediation, if necessary, of the surrounding environment is limited, if available at all. Because of the suspected age of many of these tanks, the lack of data characterizing the history and condition of the tanks and

the evidence demonstrating that numerous tanks in the area have failed and caused releases to the environment, these other tanks must be considered potential background sources of contamination in the study area.

FINGERPRINT IDENTIFICATIONS

Occasionally, it is important to try to match a petroleum product found in the ground to material that may be or may have been in one of several tanks near by. This can be a very complex situation for a chemist because each batch of petroleum has its own unique chemical signature and weathering of the petroleum in the ground will further change its signature from that shown by the material still in the tank.

When a spill is fresh (has not undergone extensive weathering) and the suspect tank has not been refilled, a good match or non-match can often be obtained. In cases where weathering of the spilled material has occurred, comparison of the relative peak heights of specific individual peaks can be used to confirm matches. The peaks used for comparing different batches of a petroleum product depend upon the GC conditions used by an analyst. It is preferable to use peaks that represent individual hydrocarbons which are comparable to each other in volatility and water solubility. Laboratories wanting to do this type of work must first establish extensive data bases showing standard variabilities among the peaks selected for matching purposes. Once this is done, the analyst can then begin to fingerprint samples to determine if the variations seen are sufficient to say that one has the same or different batches of a petroleum product.

If the spill occurred sometime in the past or is the result of a slow release from a tank that may have been filled many times during the release period, fingerprinting the spill is much more difficult. In these cases the sampling plan is of utmost importance. Samples must be taken and then analyzed to show a step by step trail of the contamination back to the source. The steps must be small enough to have comparable chemical signatures between sampling locations. Sampling must also be done to show that negative results or non-matches are found when moving away from the actual contamination path.

SUMMARY

Characterization of petroleum products is a very important part of hazardous waste investigations. It is relatively easy to distinguish between low boiling, moderate boiling and high boiling products such as gasoline, diesel and motor oil. More detailed or precise identifications of petroleum products is often dependent upon the experience of the analyst.

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Detailed identifications are complicated by the variability between each batch of petroleum product, as well as weathering effects and other degradative processes. It is sometimes possible to distinguish between batches of petroleum products by looking for additives that are in one batch but not the other. At other times the relative heights of the various peaks present in the GC signature can be used to show similarities or dissimilarities between specific batches of petroleum products.

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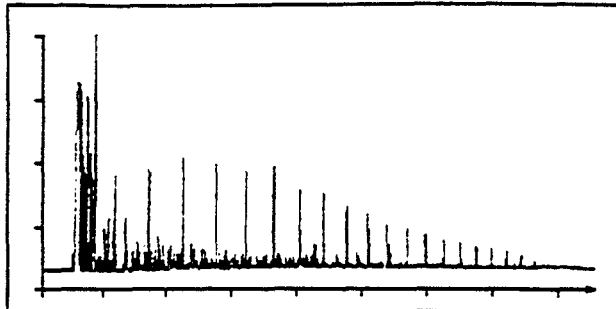


FIGURE 1: PRUDHOE BAY CRUDE OIL

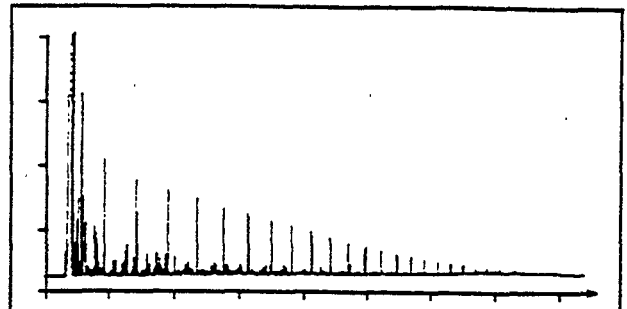


FIGURE 2: KUWAIT CRUDE OIL

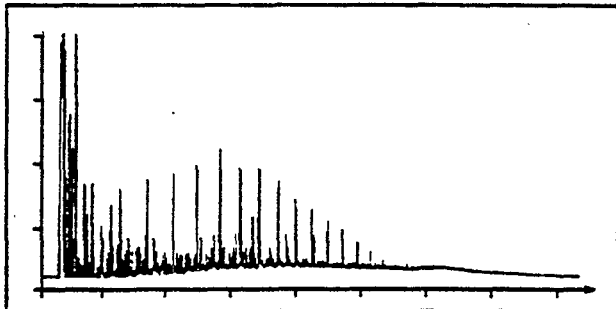


FIGURE 3: LOUISIANA CRUDE OIL

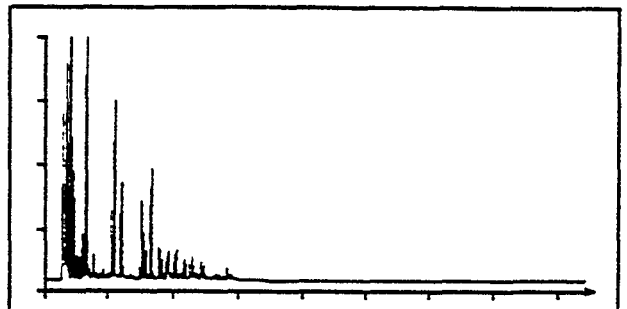


FIGURE 4: LEADED GASOLINE

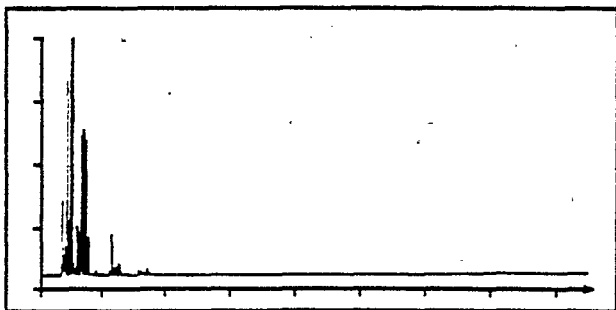


FIGURE 5: AVIATION GASOLINE

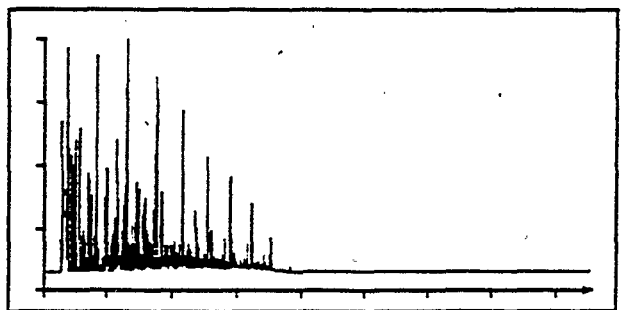


FIGURE 6: JP - 4

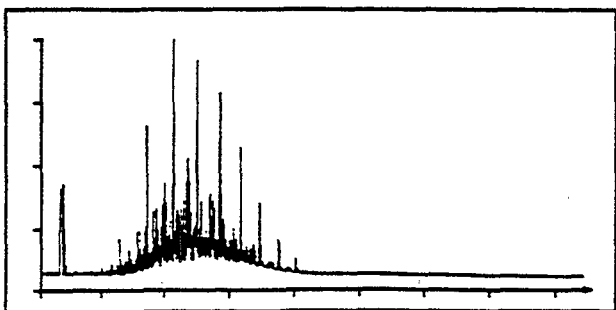


FIGURE 7: JP - 5

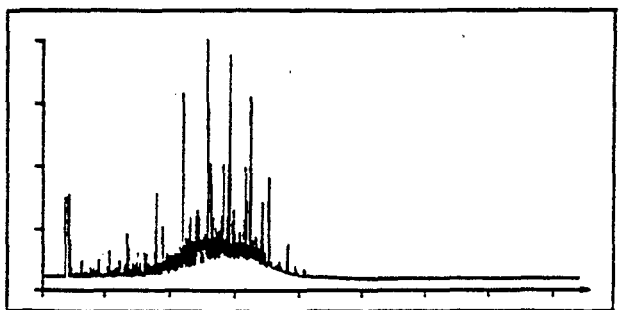


FIGURE 8: JET A

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